A11 Infantry Tank Mk.I A Technical History

P.M. Knight

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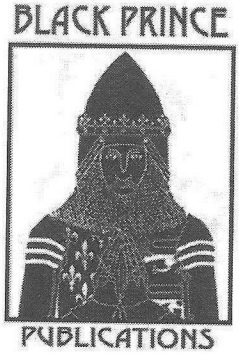
— A TECHNICAL HISTORY —

by P.M. Knight



BP077712

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ISBN 978-1-326-52895-9

Design and layout by Jakko Westerbeke

Thanks to Andreas Biermann, Bob Gregory, Andrew Hills, Craig Moore, Stephen Tegner and Nick Watts for their invaluable assistance in the research of this account.

(front cover) *Front view of early production Infantry Tank Mk.I T3439* Demon *of the 4th Battalion of the Royal Tank Regiment. The cast frontal brow of the turret has been reduced in prominence in comparison to prototype A11E1 due to the increase of the turret armour thickness from 60 to 65 mm. The driver's periscope has been given a canvas cover to exclude dust and grit from its ball mounting.* *(National Archives)*

(back cover) *3D model of the internal layout of the Infantry Tank Mk. I. This gives a good representation of just how restricted the space inside the vehicle was, the commander in particular having very little room in which to undertake his duties.* *(Stephen Tegner)*

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1. THE BIRTH OF A QUEEN

The genesis of the A11 Infantry Tank was a particularly murky affair even by the standards of the interwar period, this being largely due to the exceptionally vicious rivalries between the various advocates of armoured warfare within the British Army of the time. In the early 1930's, the responsibility for Armoured Fighting Vehicle (AFV) development in the United Kingdom was divided between three official organisations. The most prominent of these was Department 5 of the office of the Master-General of the Ordnance, or MGO5, based in the War Office in Whitehall. This organisation, headed by the current Assistant Director of Mechanization (ADM), Colonel Malden Augustus Studd (M.A. Studd), performed the supervisory role for the tank development process, drew up the requirements and specifications for new tanks, and monitored the progress of any projects that had been approved by the General Staff. MGO5, along with MGO6 (Mechanical Transport) came under the jurisdiction of the Director of Mechanization (D of M), Major-General Alan Brough, who was in turn directly answerable to the Master-General of the Ordnance (MGO) himself, Lieutenant-General Ronald Charles. The other two organisations responsible for AFV development were based at the Royal Arsenal at Woolwich, in southeast London. The first of these was the Design Department, under the Superintendent of Design (S of D), whose 'M' (Mechanization) section dealt with tracked vehicles and 'V' (Vehicular) section addressed wheeled vehicles. This department as a whole had as its main responsibility the design of armaments for all three services, with the 'M' and 'V' sections representing only a small proportion of its workload. Indeed, the Superintendent of Design himself, Colonel F.C.N. Bishop, appears not to have involved himself in AFV work in any notable way, with AFV design being under the control of his deputy, Colonel Edward Montagu Campbell Clarke, who was universally known as E.M.C. Clarke. The other significant organisation at Woolwich was the Mechanical Warfare Board, which essentially functioned as a consultancy, consisting as it did of a body of "expert" engineers who advised on particular aspects of vehicle design.

The first indication of any interest in producing a tank specifically designed for seizing prepared enemy positions came on 6th May 1933, when E.M.C. Clarke wrote a set of *Notes on the Problem of the Assault Tank* for submission to Alan Brough. This paper was most likely to have been prompted by the Director of Mechanization himself, with Clarke acknowledging that "One of the principal tasks laid down for Tanks in the present training manuals is that of direct assault on defended positions" while "Under modern conditions this must involve engagement of the A-T. [Anti-Tank] defensive weapons at decisive ranges." The training manuals referred to here were *Mechanized and Armoured Formations*, issued in 1929 and known as "the purple primer", and its successor *Modern Formations* issued in 1931. Both of these documents had been largely authored by Charles Broad in consultation with George Lindsay, who was at the time the most influential theorist within the Royal Tank Corps (RTC), among a group of armour enthusiasts that included Frederick Pile, and Lindsay's own protégé, Percy Hobart. In assessing the effectiveness of the currently available tanks in the assault role. Clarke outlined that:

> The thickness of armour carried on our service Medium tanks is about 60% of that required to be absolutely immune to S.A. fire (A.P. bullets). The tactical manuals which lay down these tactics do not visualise protection above absolute S.A.A. immunity (see *Modern Formations 1931*. App.II and III), *i.e.* the 11 m.m. cemented plate standard. Recently it has been decided to protect future Medium Tanks on the 14 m.m. basis with a view to forestalling future improvement in the penetrative power of light weapons.

The current service Medium tanks referred to here were the Vickers-designed Medium Mk. I and its derivative Medium Mk. II, which were both armed with 3 pounder (47 mm) anti-tank guns and armoured to a maximum of 8 mm thickness. This was sufficient to resist small arms (SA) rifle fire using standard (*i.e.* "ball") ammunition, but would be vulnerable to penetration from similar calibre bullets of the dedicated armour piercing (AP) type. In order for this latter type of small arms ammunition (SAA) to be defeated, it had therefore been posited in *Modern Formations* that a minimum armour basis of 11 mm of "cemented" armour be required for any new Medium tanks. "Cementation" was the contemporaneous term for carburisation, in which the original rolled homogenous armour (RHA) plate was carburised on one face by the application of carbon-bearing gases during heating. This face was then subjected to high heat that penetrated to 30 – 40% of the steel's depth, prior to the quick quenching of first the superheated, and then both sides of the plate. The result was an armour plate that was hard and brittle on its outer face, but which retained the resilience of rolled homogenous ("machinable quality") armour on the inner face, it being officially known as Cemented

Tank Armour (CTA), although the more general term for it was face-hardened armour. However, although cemented plate was superior to resisting penetrative attack on its hardened face, it was more susceptible to cracking when subjected to the blast of high explosive (HE) shells, this being due to the limited ductility at the hardened face, the problem becoming more critical due to the thinness of the plates employed. It had therefore been decided to specify 14 mm rolled homogenous armour for all future British Medium tanks, thus giving the requisite immunity against all types of rifle calibre projectile, while offering superior resistance to high explosive shells. This was the basis of Clarke's claim that the current Medium tanks, with their maximum 8 mm armour, offered around 60% of the thickness necessary (*i.e.* 14 mm) to be absolutely immune to all forms of small arms ammunition. Indeed, the convention that tank armour only need be proof against small arms fire was sufficiently accepted that the armour itself was universally referred to as BP (*i.e.* bullet proof) Plate.

It should also be noted that at this time the Medium tank was envisaged as the main equipment of the armoured force, the only other type of tank in service being the Light Tank, which was effectively a scouting machine largely intended for employment in the Cavalry. As such, the Medium tank would be expected to perform the majority of tasks expected of the armoured force, of which the most important were anticipated as being defeating the enemy tank force and the exploitation of a breakthrough in the enemy front line, these requiring a tank capable of covering a comparatively long distance at reasonable speed, while being able to deal with varied and relatively diffused enemy opposition. On the other hand, any tank optimised for the assault on prepared positions would only need to cover comparatively short distances, over what was likely to be rough, shell-pitted ground, while being able to resist a high concentration of defensive weapons. This led Clarke to assert that "The type of Tank under discussion is a modernised reversion to the War Tank, a remark that applies equally to the tactics of frontal assault." By "War Tank", he was referring to the rhomboid tanks of the Great War, which had advanced slowly over shelled ground toward the enemy trenches. Although these machines had only been thinly armoured, this factor had been less critical due to their novelty and the consequent absence of dedicated anti-tank weapons directed against them. They had also been able to be slotted into a pre-existing system of combined arms warfare, with Clarke elucidating that:

> The Tank of 1916 provided in itself the element of surprise; it was launched into a theatre of war, which had been static for nearly two years, and during which a vast accumulation of artillery power had been built up — far greater in fact than could have been effectively handled in a war of movement. None of these conditions will exist at the outbreak of a future war, nor, in the case of artillery support, could be provided for a long time.

As such, until the production of artillery pieces had been built up to a level at which supporting bombardments would be overwhelming, any assault tank would be dependent upon its own attributes for its survival. Clarke then posited a related role that such a tank could adopt, which was the accompaniment of attacks by the infantry. In this instance he maintained that "The modern unprotected soldier in the open is no less susceptible to the effect of M.G. fire than was his predecessor in the last war; since when the S.A. fire power of the defence has been steadily augmented and the chances of his survival correspondingly reduced." This was a less convincing assertion, the augmentation of small arms firepower presumably consisting of the new generation of light machine guns, which would make a comparatively small difference to the attacking infantry and have no influence on any accompanying tanks. Nonetheless, Clarke would hazard that:

> If the tactics of frontal assault are to be retained, it becomes necessary to consider the most heavily protected type of Tank that can be built within the maximum gross weight limit imposed for bridging strength, *i.e.* 18 tons, speed range and fire power being sacrificed for increased armour protection.

The bridging strength of 18 tons alluded to the Class 18 pontoon bridge, this being the heaviest mobile bridge that so far been evolved by the British Army. In order to form an estimate of the heaviest armour available within this limit, Clarke employed the example of the A7 Medium tank, an experimental model that he himself had designed. This weighed approximately 14 tons on the 14 mm basis to which it had been developed, with Clarke roughly estimating a rise to 17 tons if 20 mm armour were substituted, and 18 tons if 22 mm armour were utilised. He also produced a set of estimated penetration tables of the resistance of various thicknesses of armour to attack by a 0.8" (20 mm) autocannon that had been produced by the Elswick Ordnance Company, a subsidiary of Vickers-Armstrongs Ltd., this representing the heaviest form of anti-tank weapon that could currently be anticipated. Clarke considered four possible thicknesses of rolled homogenous armour that might be employed, these being 25 mm, 30 mm, 35 mm and 40 mm. He also posited a set of ideal equivalent cemented armour bases which were 15% thinner, these being of 22 mm,

Plate Thickness	Attack Angle	Immunity Distance (yds (m))	100% Perforation Distance (yds (m))
25 mm (RHA) or 22 mm (Cemented)	Normal (0°)	1200 (1100)	800 (730)
	20°	1100 (1000)	650 (595)
	30°	950 (870)	550 (500)
30 mm (RHA) or 26 mm (Cemented)	Normal	1030 (940)	530 (485)
	20°	850 (780)	420 (395)
	30°	770 (700)	330 (300)
35 mm (RHA) or 30.5 mm (Cemented)	Normal	800 (730)	340 (310)
	20°	660 (600)	210 (190)
	30°	550 (500)	100 (90)
40 mm (RHA) or 35 mm (Cemented)	Normal	550 (500)	140 (130)
	20°	450 (410)	0

26 mm, 30.5 mm and 35 mm. The posited resistance to penetration of these various plates are shown in the table above.

The term "normal" in this table referred to an attack directly perpendicular to the plate, with penetration becoming increasingly difficult as the angle diverged from normal, due to the increasing relative thickness of the plate, and the greater likelihood of deflection. Clarke alleged that his estimated figures, especially for the face-hardened plate, were "optimistic", as trials on the relatively thin cemented plates thus far available had demonstrated that "the degree of superiority of the cemented over the uncemented plates decreases markedly with the increasing thickness of the plates at normal attack; at oblique attack (angles of 20° or more) the superiority, if any, is not appreciable throughout the range of thicknesses." He had therefore posited "an improved type of hard-faced plate in the near future ... more favourable to the Tank than any existing data warrant." Given these conditions, and the values quoted in the table, Clarke forecast that for an 18 ton A7 Medium tank armoured to 22 mm cemented plate standard, "The normal method of siting A.T. weapons in defence makes it highly probable that some part of the Tank will be exposed to attack at angles of 30° or less at all stages of its progress and therefore it will become highly vulnerable when it arrives within about 600 yards of the main position." Once the proposed tank was in this area, Clarke noted that:

> Its lack of speed, which has to be sacrificed for increased protection, after this stage contributes to its vulnerability, for its average rate of advance is unlikely to exceed 3½ yards per second (7 m.p.h. [3 m/s or 11 km/h]) through the danger zone, if working independently. (If attacking in company with an infantry assault, its speed will be less than half that quoted)

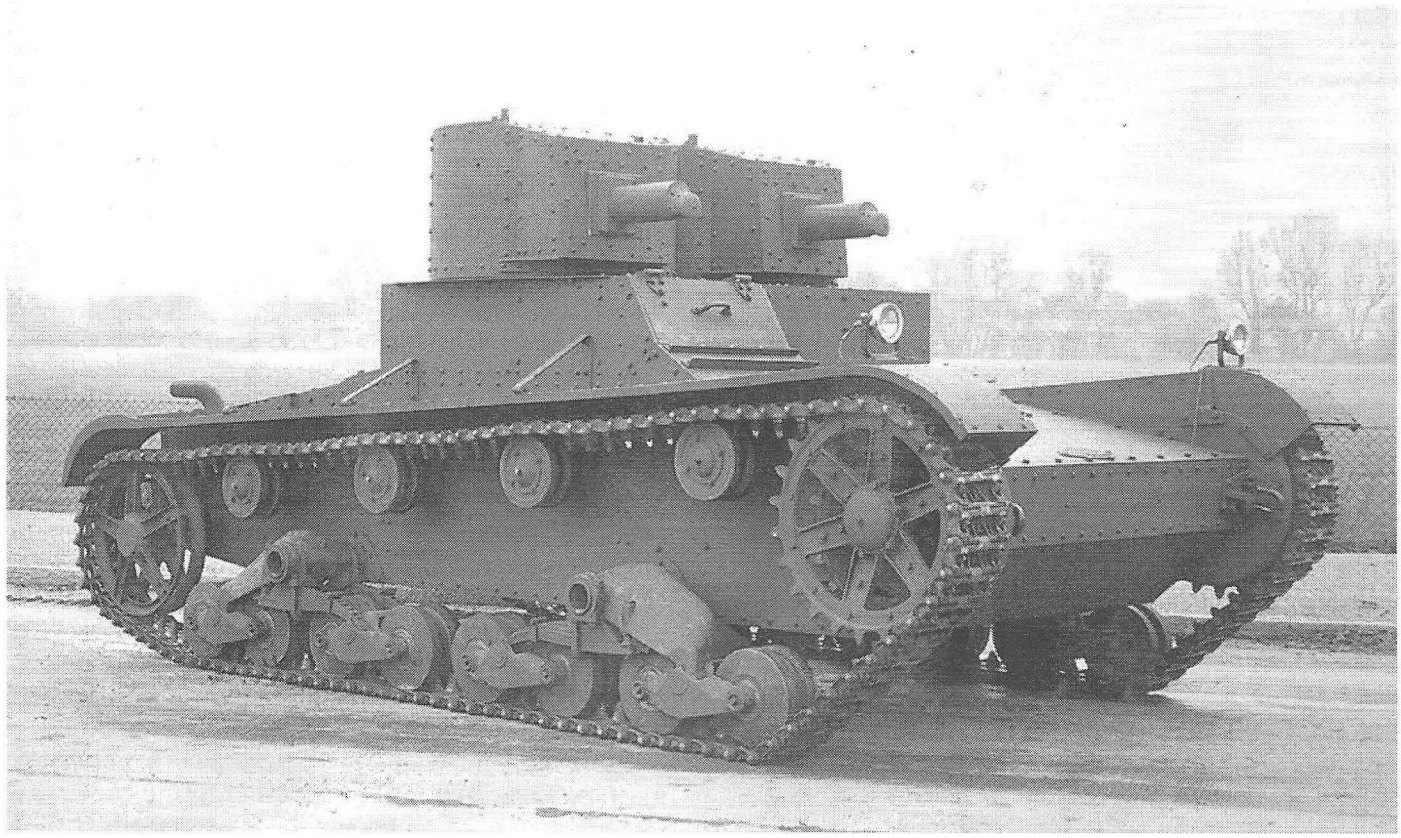
The rate of progress quoted here was based on a maximum 15 mph (24 km/h) road speed, which "would give about 11 m.p.h. [18 km/h] on good turf and about 7 m.p.h. [11 km/h] over rather broken country or gradients up to 1 in 8 on turf." Given all these factors, Clarke suggested an armour basis slightly greater than the maximum he had considered in his tables, stating that "Absolute immunity to A-T weapons would mean protection on a 42–44 m.m. cemented plate standard." If applied to his A7 tank, this would raise its weight to around 24 or 25 tons. The resulting machine would also need to be armed with a 3 pounder (47 mm) anti-tank gun, or the more powerful 2 pounder (40 mm) currently in development, and a co-axial machine gun, with stowage capacity for 90 cannon and 3000 machine gun rounds. Clarke also posited sufficient fuel for a "circuit of action" (*i.e.* range) of 40 to 50 miles (65 to 80 km), and an obstacle (*i.e.* trench) crossing capacity of 8 ft (2.4 m). Putting all these factors together, he arrived at a series of pessimistic conclusions as to the viability of such a tank, venturing that "The most heavily-armoured 18-ton assault Tank that can be built would only be semi-protected, against A.T. weapons, to which it would become highly vulnerable in the decisive stages of the fight." He further advanced that "The tactics of direct frontal assault by such Tanks under modern conditions must be hazardous and costly, even when successful", and "The artillery support available to neutralise the defending fire cannot approach the scale of the last war." If employed to assist the infantry, Clarke cautioned that "Unless and until a successful solution has been found of passing unprotected infantry on to their objectives over ground swept by heavy concentrations of M.G. fire, the development of a special type of Tank for close attack co-operation with

that arm is unjustified." Ultimately, he felt that any tank optimised for the assault would represent a reversion to the original design of tank, rather than a progressive development, and that "Its re-creation in modern form serves mainly to perpetuate the 'hammer-blow' method of frontal assault — the only method open to its prototype — in circumstances which have altered to its disadvantage in all respects."

Interest in the development of an assault tank would remain in abeyance until the arrival of a new Master-General of the Ordnance in April 1934, in the form of Lieutenant-General Sir Hugh Elles. Although he had been one of the pioneers of armoured warfare, having commanded the original Tank Corps headquarters at Bernicourt in France during the Great War, Elles had become increasingly sceptical of the survivability of the tank on the modern battlefield. As a consequence, he believed that the heavily armoured assault tank was a more viable proposition in a future war than the Medium tanks that were advocated by the Royal Tank Corps. In order to advance his ideas, Elles would bypass the Director of Mechanization, Alan Brough, and work directly with the ADM, Colonel Studd, with the result that on 14th April 1934 Studd would issue a set of requirements for "Tanks with 1" Armour". This was effectively a call for a 25 mm armour basis, which according to E.M.C. Clarke was insufficient for an assault tank. However, Clarke's analysis had been rather questionable, as although he had claimed that his armour resistance figures were optimistic, they had in fact been severely pessimistic, as in practice the future German 2-cm-KwK 30 autocannon would not be able to penetrate 25 mm of armour at even 100 yards (~100 m) at 30°, let alone the 550 yards (500 m) he had predicted. Studd's requirements would be forwarded to Colonel Noel Hudson, the president of the Mechanization Board, which had superseded the Mechanical Warfare Board at Woolwich on 1st April. Hudson accordingly discussed the matter with Clarke on that same date, 14th April, with Clarke proposing two potential tanks, the 'No. 1' at 20 tons, and the 'No. 2' at 19 tons. Although no details were recorded of these machines, No. 1 was to have a crew of four, and No. 2 a crew of three, with both having machine guns as their main armament, the weights quoted suggesting that they would have been based on the A7. Two days later, on 16th April, a further discussion would take place between Clarke and Hudson, this resulting in Clarke reducing the estimated weight of his proposed tanks by half a ton, such that No. 1 was lowered to 19½ tons, and No. 2 to 18½ tons.

Later that day, Noel Hudson would travel to Chertsey in Surrey in order to visit Vickers-Armstrongs' tank development facility, where he would meet Sir John Carden and his business partner Vivian Loyd. Chertsey had originally been the site of the two engineers' own firm, Carden-Loyd Tractors Ltd., before it had been bought by Vickers, and Hudson would now arrange for Carden to attend a meeting at the War Office on the subject of the new tanks the following day. This meeting duly went ahead on the afternoon of 17th April in Alan Brough's office, the attendees being the Director of Mechanization himself, as well as Colonels Hudson, Studd and Clarke, and Sir John Carden. The first item to be decided was the obstacle performance for the two machines, it being agreed that they would need to be able to cross a trench of width 6 ft. 6 in. (2.0 m), and surmount a vertical obstacle 3 ft. (90 cm) high. As the trench crossing capacity was lower than the anticipated 8 ft. (2.4 m) that E.M.C. Clarke had previously assumed, this permitted the consideration of tanks with a shorter track base (the length of track adjacent to the ground) than the A7. This in turn encouraged Sir John Carden to propose a pair of much lighter vehicles than had Clarke, with Carden's No. 1 weighing in at an estimated 10 tons, and his No. 2 at 8 tons. The No. 1 tank was to incorporate the "S of D's turret", this being a three man turret for general tank use that had been designed by Clarke's team at Woolwich, and which was designed to mount the 3 pounder anti-tank gun and a co-axial 0.303 in. (7.7 mm) Vickers machine gun. This turret was fitted to the prototype models of the A7, although for the new No. 1 tank with 1" armour, it would mount machine guns only, the meeting noting that "It was generally agreed that a lot of ammunition would be required in order to keep the heads of the Hostile Infantry down." Carden proposed that this tank should be based on his proposed A9 Medium tank, which was a lighter rival to Clarke's A7, and which already incorporated a 14 mm armour basis. He estimated that the resulting vehicle would take around 18 months to produce, although "the problem was a new one and there were many unknowns". This was simply because armouring a tank to a 25 mm basis was a radical departure for the time, as it represented a near doubling of the existing proposed maximum armour basis of 14 mm, which was itself thought to be a bold step forwards. Noel Hudson stated that he felt certain that a 2 pounder (40 mm) or other kind of cannon would be required for the new tank and that "this being the case it would pay the War Department in the long run, to have two vehicles on the same lines with most components interchangeable, *i.e.* the A.9 and the No. 1 type of tank."

As for the smaller machine, Carden submitted that "He could produce No. 2 within a year and could guarantee satisfaction by using many components of his 6 ton tank whose performance was well known." This was a reference to the Vickers 6-Ton tank of 1928, designed by Carden, which although not adopted by the British Army had already been exported to Poland as the Mark E. The 6-Ton tank came in two variants, the Type A with two one-man turrets, each with a



The twin turreted version of the Vickers Mark E, or 6 ton tank. This was a commercially successful design that was the original inspiration for a small Infantry tank, its suspension being adapted for the Dragon Mk. IV, and thence the Infantry Tank Mk. I. (National Archives)

single Vickers machine gun, and the Type B with a single two-man turret mounting a 3 pounder anti-tank gun and co-axial Vickers machine gun. Both these variants featured rolled homogenous armour of 13 mm on the hull front and hull sides, and 8 mm at the hull rear, with 13 mm all round on both types of turret. Carden's proposal here seems to have been to adapt the Type A version of this machine to mount 25 mm armour all over, with the number of machine guns turrets being reduced from two to one in order to compensate for the increased weight of armour. The number of crew members would thus be reduced from three to two, the meeting minutes relating Carden's concern that "the 3-man tank design was doubtful with the 14 mm. standard and impossible for the 25 mm. standard."

On 24th April a meeting was held of the Chief of the Imperial General Staff's Research Committee, during which the commander of the 1st Tank Brigade, Major-General Percy Hobart, presented a paper on the type of tank needed for close cooperation with the infantry. Hobart noted that there were "two schools of thought" on this matter, the first being the "small tank school", who posited that the infantry required armour assistance to move their heavy weapons (such as machine guns and mortars) into positions on the flanks and in the rear of the enemy, thus assuring their advance. The type of tank that this school envisaged would be small and inconspicuous, while also being able to surmount simple wire obstacles, its concept most closely matching Sir John Carden's No. 2 model. The emphasis would be on cross country ability rather than speed, while it would also be available in sufficient numbers to ensure that at least some vehicles arrived at their objective. The second camp was the "heavy tank school", who maintained that the lesson of the previous war was that a tank needed to carry a cannon in order to deal with machine guns concealed behind substantial protection. This type of machine should be able to accompany the infantry across country at their pace, although its more conspicuous size and slow speed would necessitate thick armour, it conforming more to Sir John Carden's No. 1 model. As there were "pros and cons" associated with the proposals from both schools, Hobart submitted that pilot models (*i.e.* prototypes) be designed of both types, with the small tank being armed with either a 0.303-in. or 0.5-in. (7.7 mm or 12.7 mm) Vickers machine gun. The General Staff then drafted a provisional specification for what was now called an "infantry tank", this calling for a minimum of 25.4 mm (1") of armour all round, and either a 2-pdr (40 mm) gun or high velocity 0.5-in. (12.7 mm) machine gun for engaging hostile tanks, as well as one or two 0.303-in. (7.7 mm) machine guns for dealing with infantry. The maximum speed was to

be 10 mph (16 km/h) on flat ground and 5 mph (8 km/h) across country, while the weight was to be nine tons. As such, this specification generally conformed to the No. 1 model, although subsequent discussion saw the weight being raised to 18 tons, presumably to permit the possibility of an A7 derived machine.

A further meeting was held at the War Office on 27th April, attended by M.A. Studd, Noel Hudson and Sir John Carden. Also present was Lieutenant-Colonel Robert Hallam Studdert on behalf of the Superintendent of Design at Woolwich, as well as Captain David Rycroft and Captain Fitzroy Tozer Chapman of MGO5. The subject of this meeting was the "New tank with 1" [25 mm] armour to carry a 2 or 3 pr. [40 or 47 mm] gun", in compliance with the General Staff's draft specification. It was also stated that "This tank will be known as A.10.E.1.", the 'A' number indicating that the No. 1 tank was now the subject of an official development project. In fact the tank type would be the A10, the "E1" being the suffix that would be appended to the mild steel experimental prototype that would eventually be ordered. The meeting itself was concerned with the drafting of ten propositions for the A10 that needed to be resolved by future discussion. These included whether an additional (*i.e.* hull mounted) machine gun would be necessary, whether provision for a future upgrade to a 30 mm armour standard should be considered "to provide a safety factor", and whether internal armouring of 1 in. (25 mm) thickness ought to be provided around the fuel tanks. Other questions included the need for fitting a wireless, the necessity for protection against gas attack, and whether Carden should be allowed to use non-standard or bespoke components, this latter issue potentially affecting the supply of spares in wartime. Perhaps the most unusual of the dilemmas posed was whether the proposed tank should be given "Additional power to enable operation at a height of 8000 feet [2400 m]." This perhaps suggested the possibility of it being employed on the North-West Frontier of India. The only one of these propositions that was decided during this meeting was in regards to the extra machine gun, which was rejected. Otherwise, the meeting minutes noted that:

> Sir John Carden said that he thought he could work in this design on the lines of the 'Bright Idea'. He said the whole problem was this:—

Prototype A10E1, the original Infantry tank that was soon abandoned due to its 25 mm armour basis, which was rendered inadequate by the new generation of anti-tank guns. A revised version of this design would nonetheless achieve some success as the Cruiser Tank Mk. II. (National Archives)

> If the tank could be produced at a weight not exceeding 10 tons it would be extremely promising. If it came out over 10 tons it would be, in his opinion, a very doubtful proposition.

The "Bright Idea" was Carden's nickname for his A9 tank, which had resulted from an initiative to utilise "off the shelf" commercial water cooled automobile engines for medium tanks in place of the air cooled Armstrong-Siddeley V8 engines that had previously been selected to power the British Army's next generation of medium tanks. These latter had been fitted to the Vickers designed A6 and the first two prototypes of the A7 (A7E1 and A7E2), but the lack of air ventilation in the relatively closed engine compartments meant that they were effectively having to be cooled by their own lubricating oil, this leading to continual breakdowns due to overheating. However the commercial automobile engines available were not considered sufficiently powerful for tank use, and in December 1933 E.M.C. Clarke had advised M.A. Studd that the alternatives to air cooled engines were either to adapt a modern water cooled aero engine, or else to utilise the less powerful automobile engines in pairs. This latter route had drawbacks in terms of weight, accessibility and complexity, as the paired engines would need to be "handed" (*i.e.* their crankshafts had to rotate in opposite directions) in order for their common output to be transferred to the gearbox, this in turn complicating the provision of spares. Clarke had understandably favoured adapting an aero engine, and had initiated preliminary discussions with Rolls-Royce Ltd. with a view to modifying their Kestrel engine for tank use, with the resulting design potentially being available for manufacture by other firms. However, Rolls-Royce's engine production had become monopolised by the Air Ministry on behalf of the Royal Air Force, and the firm's design staff were already heavily engaged, which in turn indicated that the War Office would have to pay the full rate for any redesign and development work. As a result, the latest prototype of the A7 tank, the A7E3, was being developed around twin commercial automobile engines. The A9 on the other hand represented Carden's "bright idea" that a 14 mm armour basis tank could be powered by a single commercial water cooled engine if thinner armour was employed in a sloped configuration, avoiding vertical orientation wherever possible. As such, the effective thickness of the armour to a horizontally directed projectile would remain at 14 mm, while the weight of the armour utilised could be drastically lower than on the A7 machines.

The decision to proceed with the No. 1 as the A10 meant that the smaller No. 2 machine would be shelved, at least for the time being. A contract for the first mild steel prototype A9, which would be known as A9E1, was placed on 15th June, with the resulting vehicle being expected to weigh seven tons as a bare vehicle, prior to the fitting of guns and gun mountings, and all ancillary equipment. The A9E1 was to initially be configured as a "Close Support" tank, which meant that its primary armament was to be a 3.7-in. (94 mm) Smoke Mortar (also known as a 15 pounder mortar), this in fact being a howitzer for firing covering smoke when tanks were out of range of their own artillery. This mortar was interchangeable with the 3 pounder anti-tank gun, and would be accompanied by a co-axial 0.303-in. (7.7 mm) Vickers Machine Gun in the same Woolwich-designed turret as fitted to the A7. The front of the tank was to be covered by an effective arc of machine gun fire of not less than 190°, this meaning that either one or two machine guns would be mounted in the front of the hull, the resulting crew members numbering five or six. The contract for A10E1 would not be placed until 1st November, this vehicle by now being officially known as the "Tank, Experimental, Infantry A.10 type". That it was designated as an "Infantry" tank indicated that its use was to be biased towards the second of the two offensive roles that E.M.C. Clarke had considered, that of escorting the infantry onto their objectives, rather than being a pure assault tank. The crew of the A10E1 would only be four due to the deletion of the hull machine gun(s), the saving in weight helping to facilitate the necessary increase in armour thickness, with the expected weight of the tank being stipulated to not exceed 15 tons. It was also mandated that the new tank would have a maximum road speed "not less than" 10 mph (16 km/h), and a cross country speed of at least 5 mph (8 km/h), these being significant reductions from the anticipated 25 mph (40 km/h) road and 18 mph (30 km/h) cross country speeds of A9E1, but entirely congruent with the infantry support role. The range of the A10E1 was to be only 60 miles (100 km) in comparison to the expected 150 miles (240 km) of A9E1, this reflecting the principle that the tank would normally be delivered to the battle area by rail, and only be used for a specific limited operation. The A10E1 was to be armed, as expected, with a 3 pounder anti-tank gun in the turret accompanied by a co-axial 0.303-in. Vickers Machine Gun, while for its obstacle crossing ability, it was laid down that:

> It must be able to climb a slope of 35° and to negotiate a vertical obstacle having a minimum height of 2 feet [60 cm]; the minimum trench crossing capacity is to be 6 feet [1.8 m] and the vehicle must be able to ford water of a minimum depth of 3 feet [90 cm].

This marked a reduction of the standard proposed at the meeting on 17th April, which had postulated a trench crossing capacity of 6 ft. 6 in. (2.0 m), and a vertical obstacle clearance of 3 ft. (90 cm). On 2nd February 1935, E.M.C. Clarke would briefly revisit his

Notes on the Problem of the Assault Tank in the light of the decision to proceed with A10E1, and the ongoing developments in anti-tank weaponry. Clarke recalled that the penetration table he had compiled in his paper had only taken into account the effectiveness of an assault tank's armour against a 0.8" (20mm) Elswick gun, whereas it was now the case that:

> The Continental powers are now developing a heavier AT weapon 37 – 40 mm. We are developing a 2 pr (39 mm). The penetrative performance of this 2 pr has been demonstrated by trial to be
>
> Against 25 mm B.P. Clean perforation at angles of 45° of normal at 1100 yards [1000 m].
>
> Against 38 mm (1½") BP. Clean perforation at angles of 30° at 700 yards [640 m].
>
> Against such weapons therefore the chances of direct assault are a great deal less even than those discussed in this paper.

The most likely opponent was the anti-tank gun that the Germans were developing, this being the 3.7 cm *Panzerabwehrkanone* (3,7-cm-Pak), although other such guns in this class would include the Swedish Bofors and Czech Škoda 37 mm anti-tank guns, and the Austrian Böhler 47 mm gun. The 2 pounder (40 mm) anti-tank gun was being developed at Woolwich under Colonel David Sydney Carlyon Evans (D.S.C. Evans), as either a towed anti-tank or a tank-mounted gun, the expectation being that it would supersede the 3 pounder (47 mm). Clarke would issue a "condensed revision" of his original May 1933 paper during July 1935, this now being entitled *Notes on the Infantry Tank*. In it, he would question "The Value of 25 m.m. Protection", asserting that "It can hardly be disputed that the ability of the Tank to press home a direct attack depends on the thickness of its hide." He accordingly propounded that "The first question that arises, therefore is the resisting quality of this hide to the anti-Tank weapons of the defenders." To answer this, Clarke provided the results of a 2 pounder trial that had been conducted towards the end of 1934 against various thicknesses of armour plate at the Royal Artillery's Gunnery School at Shoeburyness in Essex, these being outlined in the table at the bottom of this page.

Armour Thickness (mm)	Attack Angle	Penetration Distance (yds (m))
25	30° to 45°	1150 (1050)
30	Normal	1900 (1750)
	20°	1750 (1600)
	40°	950 (870)
40	Normal	1750 (1600)
	20°	600 (550)
	40°	*Failed at 300 (275)*
60	Normal	*Failed at 350 (320)*

The clear inference from this table was that in order to resist the anticipated close range anti-tank fire that would be encountered when escorting infantry into the attack on a prepared position, at least 60 mm of armour would be required at the front of the vehicle, and probably also at the sides. This was far in excess of any thickness of armour that had hitherto been employed on tanks. Clarke accordingly recapitulated the criticisms of the Infantry tank role that he had made in his previous paper, these being based on the premise that the 25 mm armour basis would be retained. As such, he reiterated that:

> The Infantry Tank will be highly vulnerable to modern A.T. weapons. The tactics of direct assault on the centres of enemy resistance will be hazardous and costly, since they provide the conditions most favourable to defensive weapons and least suited to the offensive characteristics of A.F.V's.

Clarke once again emphasized the likely absence of artillery support of sufficient density to assist the assault, concluding that:

> Unless and until the problem is solved of passing unprotected infantry on to their objectives over ground swept by increasingly heavy concentrations of S.A. fire, the *raison d'etre* of a special type of A.F.V. to accompany them is not obvious. By conforming to the speed of the footsoldier, it will increase its own vulnerability. The Infantry Tank is a throw-back to its war time ancestor. It is required to perform the same functions but in circumstances which have altered to its disadvantage in all respects.

The potential role of the Infantry tank was sketched out in a paper of 9th September 1935 entitled *Future Organization of the British Army*, this being written by the head of the Army himself, Field Marshal Archibald Montgomery-Massingberd, the Chief of the Imperial General Staff (CIGS). This paper was primarily concerned with the formation of what was known as the Field Force, this being the portion of the Army that would deployed to the Continent to blunt any aggression that might disrupt the existing balance of power. In practice this would almost certainly mean delivering a sufficiently flexible but effective force to assist France and the Low Countries in repelling a surprise German attack. Montgomery-Massingberd posited that:

> The Great War has left a firm conviction among European nations that a long drawn out struggle is disastrous even for the victor. There are indications that strenuous endeavours will be concentrated, in any future war, on securing an early decision.

He moreover observed that:

> Germany, we believe, is training for mobile operations. For her in the West, the problem is difficult; not only is the area of manoeuvre restricted, but the enemy will be assisted by an elaborate system of fortifications.

The fortifications referred to here mainly consisted of the Maginot Line that protected the French frontier with Germany, its purpose according to the CIGS being "to economize man-power, to redress the balance of numbers and to free the Field Army to meet the Germans on the flanks." He noted that "The French believe that the Germans will try to force a decision in the opening stages of the campaign", and that the Germans accordingly had two basic options. These were to launch a surprise attack on a selected area of the fortifications by a small specialised force, or to outflank the fortifications, either via Switzerland to the south or Belgium and the Netherlands to the north. By far the most likely option was a flanking attack through the Low Countries, with Montgomery-Massingberd portending that "The French hope that Germany would not obtain a rapid decision, and consider that the war might be expected to pass through certain clearly defined phases similar to those experienced in the Great War." The first such stage would be the mobilisation period, during which "Either side may gain a great initial advantage by mobile operations conducted principally by mechanized forces and aircraft", and so "It is in this most important stage that the prompt arrival of the 1st Contingent of our Field Force may have a decisive influence." If neither side succeeded in gaining any initial advantage, then the second stage would be a stabilisation of the front, with the CIGS suggesting that "It is in this stage that our 2nd, 3rd and 4th Contingents will be of great value if they arrive in good time." The third stage would be static warfare, of a similar kind to that experienced during the Great War, with the final fourth stage emerging when one side managed to break through the enemy lines and exploit their success until victory. Should Belgium be attacked, the Belgians intended to enact a series of delaying actions at the frontier and along the Albert Canal, the CIGS relaying that "The hope of the Belgians is that French and British reinforcements will arrive in time to stabilize a continuous front ... but, should that not be possible, the Belgians anticipate a retirement to the line of the River Scheldt." This would necessitate the prompt arrival of the 1st Contingent of the Field Force, with Montgomery-Massingberd outlining that:

> The size of the force with which we must be prepared to intervene initially cannot be large. Financial considerations alone, in view of our other commitments, will limit its size. But apart from financial considerations, a small force which is better trained, better organized, better equipped and more mobile than the armies of Continental Powers is likely to have a greater moral and material influence than a much larger force which is less efficient.

The all-important 1st Contingent was to be ready within one month of the first day of mobilisation, this consisting of two corps, each of two infantry divisions, the Mobile Division, two air defence brigades and four Army tank battalions. All of these would be Regular formations, the proposed Mobile Division being the British Army's primary mechanized force, which was composed of the 1st Tank Brigade under Percy Hobart and six Cavalry regiments. The terms "battalion and "regiment" referred to similarly sized units, with "regiment" being the term used by the Cavalry and "battalion" being preferred by the Royal Tank Corps. The Tank Brigade was mainly equipped with Medium tanks with a few Light tanks for reconnaissance, while the Cavalry regiments were intended to convert from horses to Light tanks. The four Army tank battalions would all be equipped with Infantry tanks, which at the present time theoretically meant A10's, as well as a few Light tanks for scouting and reconnaissance. The Infantry tanks would also be known as Army tanks because they were external to the dedicated Mobile Division, and were pooled for assignment within the Army, the standard allocation being one Army tank battalion to each infantry division. The CIGS echoed E.M.C. Clarke by warning that:

> Apart from the decision to include in corps troops battalions of infantry tanks for close co-operation with it, no radical change has been attempted in the organization of the infantry division. Although the defensive power has been increased by the addition of machine guns, and anti-tank guns, its offensive power is less than at the end of the Great War, since the mass of artillery and large numbers of tanks then available no longer exist.

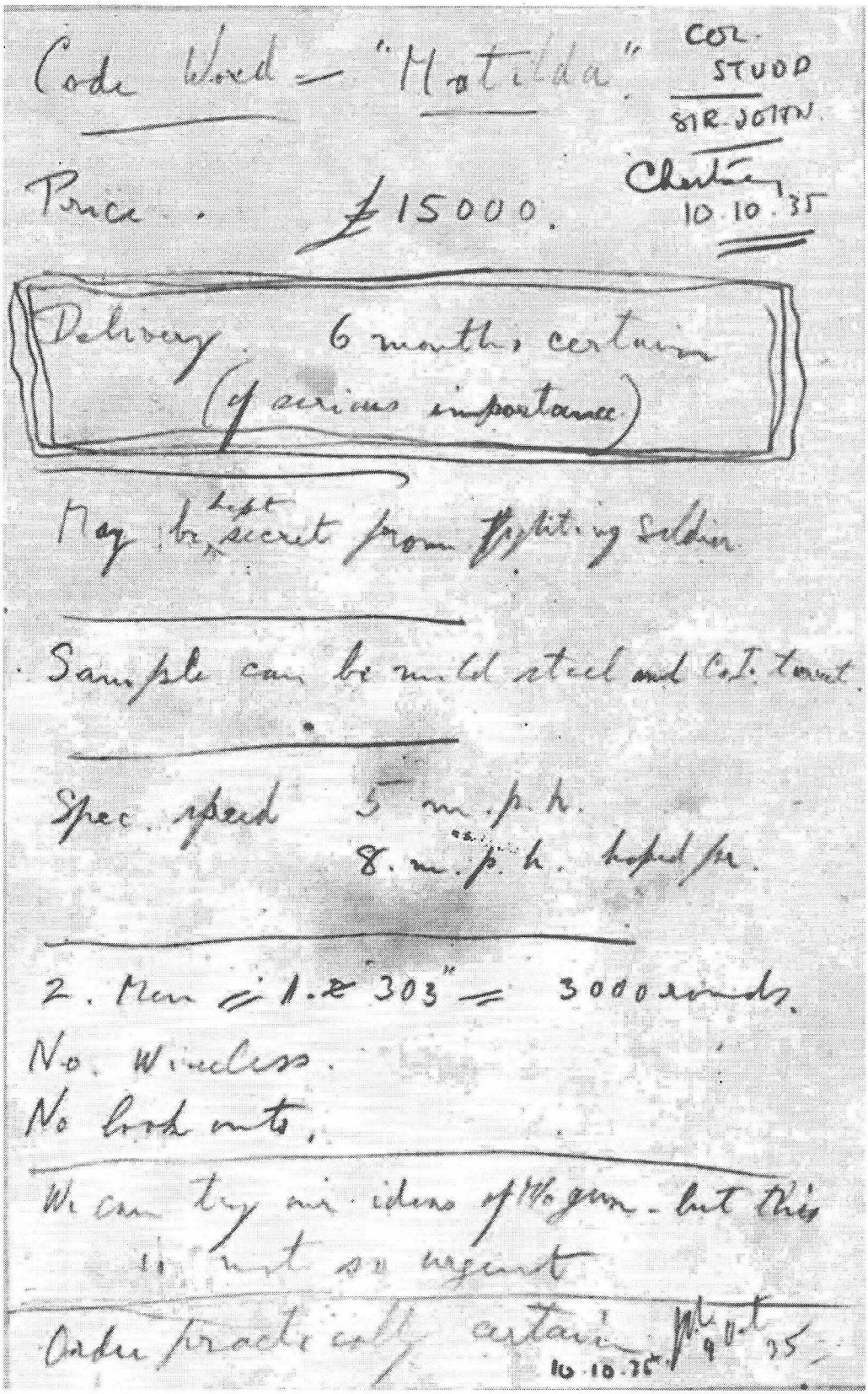
Regarding the menace of enemy small arms, he directly quoted the Kirke Committee, who had issued a report on the lessons to be garnered from the Great War, stating that "At present, even in an advanced

guard action, hostile machine guns tend to produce immediate paralysis". The 2nd, 3rd and 4th Contingents would be made up from the reservist Territorial Army (TA) as part of the anticipated army expansion scheme, and would be available respectively four, six, and eight months after the first day of mobilisation. Each of these contingents would include a corps of four divisions and four Army tank battalions, among the other formations assigned to them. The entire Field Force would therefore incorporate a total of sixteen combined Army tank battalions, this meaning that the proportion of Infantry tanks assigned for Continental operations would far outweigh the Medium tanks of the Mobile Division's Tank Brigade. This in turn was because there were not the financial resources to produce and store sufficient Medium tanks to equip additional mobile divisions to accompany the TA contingents, these tanks only becoming available as production ramped up on the outset of war. It was therefore posited that:

> Such contingents could carry out a valuable defensive role without necessarily having the same striking power and mobility as the first regular contingent. As far as circumstances permit, however, the Territorial divisions should be replicas of the Regular formations. It must be realized that even for defence they would have to be supported by adequate artillery and anti-tank weapons, an up-to-date organization for machine-guns and a proportion of army tanks which will always be valuable for counter-attack.

As such, the Infantry tanks would adopt a limited but flexible role, being able to retake lost positions, although they would be unsuitable for any subsequent decisive exploitation. Ultimately though, their presence was mainly to provide the Territorials with a measure of armour support, which would otherwise be absent. As it was becoming increasingly apparent that the 25 mm protection of the A10 was going to become inadequate for the Infantry tank role, Sir Hugh Elles would dispatch his most trusted deputy, M.A. Studd, to Chertsey on 10th October in order to consult with Sir John Carden. As E.M.C. Clarke had indicated, an armour basis of 60 mm was likely to be necessary in order to penetrate established defensive positions, Carden would take the opportunity to resurrect his No. 2 machine, albeit adapted to a 60 mm armour basis. The meeting between Studd and Carden generated some brief, hand-written notes, which included a sketch of what Carden had already envisaged, this being a very simple tank with a small turret armed only with a single 0.303-in. (7.7 mm) Vickers Machine Gun, which was provided with 3000 rounds. Its suspension was to consist of eight road wheels on each side, these being arranged in four pairs and being sprung by the Vickers-Horstmann suspension type, as already used on the firm's range of light tanks. The drive sprockets were to be at the front of the vehicle, and the idler wheels at the rear, the track being supported on its return by four discrete return rollers. The expected speed of the new tank was to be 5 mph (8 km/h), although 8 mph (13 km/h) was "hoped for", while the trench crossing capacity was to be an ambitious 8 ft. (2.4 m), in line with E.M.C. Clarke's original speculations. As with the original No. 2 machine it would have a two man crew, these being the driver and the commander/gunner. The adoption of what would obviously be a very small tank enabled it to employ a single commercial petrol engine in the same manner as A9 and A10, while carrying a much heavier armour basis, the principle being to compensate for the much greater material density of the thicker armour by decreasing the volume that it had to cover. The compact interior would mean that no wireless was expected to be fitted, the meeting minutes also stipulating no lookouts, presumably because of the difficulty of manipulating them from inside the vehicle, and because of the volume of small arms fire these would be likely to receive. The written minutes rather cryptically stated that "We can try our ideas of M/c gun, but this is not as urgent", this intimating that machine gun types other than the Vickers were also under consideration. A single "sample" (*i.e.* prototype) of the new machine was to be made, priced at £15,000, it being mentioned that this could be built with a mild steel hull and cast iron turret, with a subsequent production order being "practically certain". The "certain" delivery of the sample was to be within six months, this date being "of serious importance". There were, however, two anomalies among the points that Studd and Carden had agreed. The first was that the new tank would, highly unusually, be given a codename, this being "Matilda". The second was that the entire project should be "kept secret from [the] fighting soldier". The explanation for these anomalies would only be revealed several years later in a letter from the retired Studd to Major-General John Scott Crawford, dated 15th March 1943. Crawford, who had been employed in MGO5 under Studd, had casually enquired how the Matilda had come to be named. In his reply Studd revealed that "The M.G.O. sanctioned MATILDA himself, and it was not inaugurated by any request of the General Staff." He then disclosed that:

> After deciding how to build MATILDA, Carden and I went to lunch at a 'pub' at Chertsey and discussed a name for our new Tank. This was how I hit on the name 'MATILDA'.
>
> It was obviously 'female' because it did not carry a cannon. We decided to give it the name of one of


Code Word — "Matilda" COL. STUDD
SIR JOHN
Price. £15000. Chertsey 10.10.35
Delivery. 6 months certain
(of serious importance)
May be kept secret from Fighting Soldier
Sample can be mild steel and C.I. turret.
Spec. speed 5 m.p.h.
8. m.p.h. hoped for.
2. Mgs = 1 x 303" = 3000 rounds.
No. Wireless.
No Instruments.
We can try our idea of Mg gun - but this is not so urgent
Order practically certain 9.10.35
10.10.35

The notes of the meeting between Colonel Malden Augustus Studd and Sir John Carden at Chertsey on 10th October 1935. (The Tank Museum)

In conclusion I would like to say a few words about the " MATILDA" Tank.

The M.G.O was always keen to produce a Tank with heavy armour. The General Staff and Royal Tank Corps were not interested. Knowing how A/T weapons were progressing I visited Sir John Carden one day at Chertsey and asked him how we could produce a reliable Tank on a " 60mm basis of armour" quickly.

We had to rely on known types of commercial engines and known Transmission and suspensions etc, otherwise, on our past experience, we would be in for a host of " Teething troubles" involving re-design, which might take even " years " to perfect. We therefore built MATILDA round a Ford V8 engine, about 6ft high, but only taking a 2 man crew, and one Machine Gun. Its speed would also be only about 10 mph. Our idea was that it would be used as an "I" Tank to help the infantry to seize a definite objective, and not to use it as part of an Armoured brigade or division. It was proof against all known A/T weapons of the time and this was proved in France in 1940. It was never meant for a role independant of infantry, as it was too slow. (It cost about £6000 in production).

Before I left (1936) " MATILDA II " (Waltzing Matilda) was inaugurated with 3 men - a co-axial 2 Pdr. and MG - a speed of 15 mph - and a 70mm basis.

In view of the experience of this War I felt that we were on the right lines in starting a " Line " in Tanks with heavy armour. The M.G.O sanctioned MATILDA himself, and it was not inaugurated by any request of the General Staff.

I think a little credit might have been assigned to us for this new departure in Tank design as it has proved itself as the prototype of all Tanks used in the War today (few are under the 60 mm basis).

After deciding how to build MATILDA, Carden and I went to lunch at a " pub " at Chertsey and discussed a name for our new Tank. This was how I hit on the name " MATILDA " .

It was obviously " female " because it did not carry a cannon. We decided to give it the name of one of the Queens of England. It would obviously be a slow moving Tank and so we tried to think of the name of one of the Queens of England, which to us sounded rather " slow ".

We hit on " MATILDA ", which has remained as the Tanks name ever since.

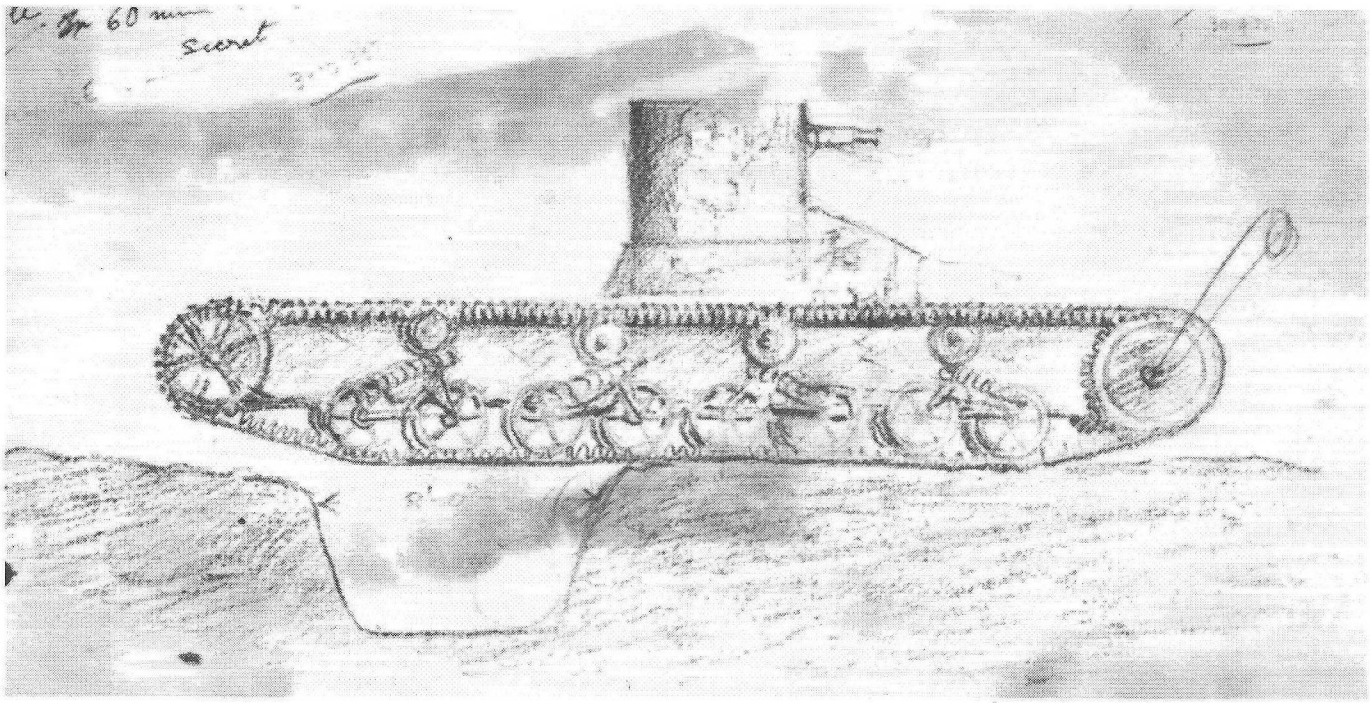
Sincerely,

M.A. Studd.

6. Park Mansions,
Knightsbridge,
London S.W.

15.3.43.

Excerpt from M.A. Studd's reply to Major-General John Scott Crawford on 15th March 1943, revealing how the name "Matilda" was chosen. (Churchill Archives Centre)



Sir John Carden's sketch of a two-man infantry tank, from which A11 was evolved.

the Queens of England. It would obviously be a slow moving Tank and so we tried to think of one of the Queens of England, which to us sounded rather 'slow'.

We hit on 'MATILDA', which has remained as the Tanks [*sic*] name ever since.

In fact there had been three Queen Matildas during the 11th and 12th Centuries, these being the wives of William the Conqueror, Henry I, and King Stephen. It had been the convention during the Great War that all cannon armed tanks were "male" and all machine gun armed tanks were "female", this being carried forward with Studd and Carden's new machine, which would of course be employed much in the manner of a Great War tank. The fact that Hugh Elles was pursuing this vehicle without informing the General Staff explained the comment about it being "kept secret from [the] fighting soldier". Elles was effectively keeping the new tank a secret from the entire British Army, and as far as can be ascertained, only he and Studd knew about it. This also explains why a codename was necessary, because if the tank was being hidden from the Army, and by extrapolation the official tank development establishment, then no development 'A' number could be allocated. This indeed was confirmed by the Second Report of the Mechanization Board, of 31st December 1935, which listed all the active projects for tanks and armoured fighting vehicles, the Matilda going unmentioned. Finally, the reason that Elles may have wanted to keep the Matilda a secret was because he had some dangerous enemies within the British Army, and indeed farther afield, who did not like his sceptical view of the efficacy of tanks, and the limited roles he envisaged them performing. The Matilda was going against the conceptual grain favoured by the Royal Tank Corps, who under the influence of Percy Hobart were seeking large, fast, all-purpose machines that took on the dominant role on the battlefield.

The new tank would nonetheless become a hostage to events, and its genesis would be severely interrupted by the tragic death of Sir John Carden in an air crash in December 1935, his work henceforth being continued by his deputy, Leslie Little, who would become the Chief Engineer at Chertsey. During February 1936, two important figures would join MGO5, in the form of Major-General Alexander Davidson and Colonel Giffard Le Quesne Martel. These were the intended replacements for Alan Brough as Director of Mechanization, and M.A. Studd as the Assistant Director of Mechanization. Although their terms were not due to officially commence until September, they would both "shadow" the current occupants of these roles in order to equip themselves for the challenges ahead. Davidson's military background had been in wheeled road vehicles, having commanded one of the first ever Mechanical Transport sections during the Boer War. Shortly before the Great War he had been the secretary of the Mechanical Transport Commission and had contributed to the enormous expansion of the Army's road transport when the war commenced. During the war itself, he had been on the staff of the Director of Supplies and Transport at Saint-Omer in France, and from 1927 to 1931 he had been the chairman of the Technical Committee of the Mechanical

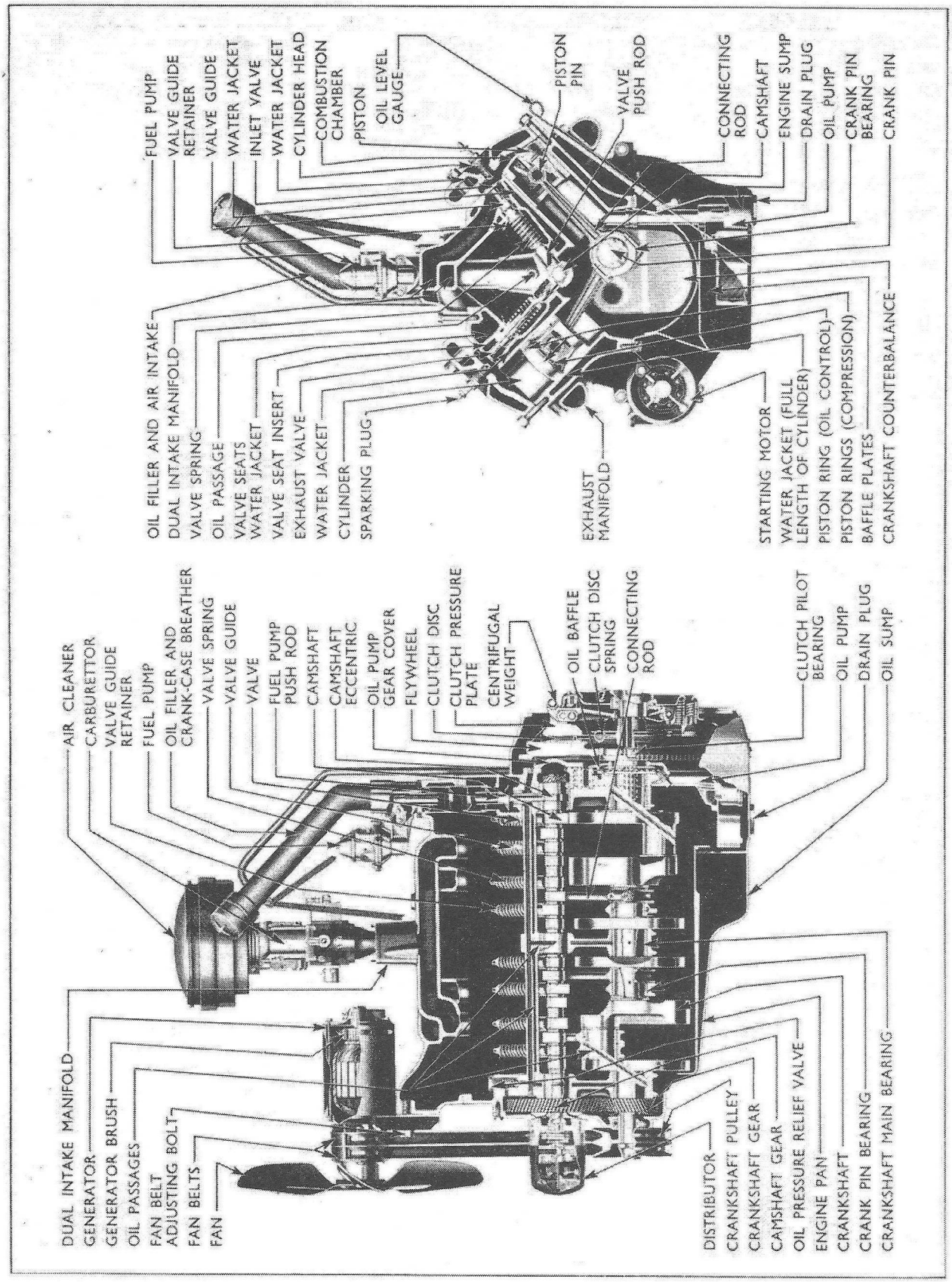
Warfare Board. Davidson was a quiet man who nonetheless tended to provoke some quite extreme reactions. Those who admired him ascribed his reticence to his extreme shyness, which they argued masked his keen technical ability, while those who excoriated him attributed his reserve to insecurity, indecisiveness, and sometimes even to cowardice. Crucially, however, Davidson was as strong a supporter of the Infantry tank concept as Hugh Elles himself, and this may have gone some way to sealing his appointment. Giffard Le Quesne Martel, commonly known as 'Q' Martel, was in many ways the polar opposite of Davidson, being energetic, ambitious, focused, and only too keen to broadcast his opinions. Martel had served under Elles as an operations officer at Bernicourt during the Great War, and so was a known quantity even though his own ideas relating to tank design differed greatly from the MGO's.

During May 1936, the War Office's requirements for Light, Medium and Infantry tanks were laid out in their Memorandum No. 9 to the Treasury Inter-Service Committee (TISC), which reviewed funding requests submitted by the Committee for Imperial Defence on behalf of the Admiralty, Air Ministry and War Office. These requirements were centred on equipping the 1st Contingent of the Field Force, and marked the first tentative step in the rearmament of the Army. The Tank Brigade of the Mobile Division would be allocated a headquarters of 5 Medium and 4 Light tanks, three "mixed" battalions each consisting of 27 Medium and 23 Light tanks, and a single light tank battalion of 59 Light tanks. The four Army tank battalions, which as we have seen were to be attached to the infantry divisions of the Field Force, were each to comprise 50 Infantry tanks and 4 Light tanks. In addition, two Cavalry regiments were to become mechanized, holding 58 Light tanks each, and one other Royal Tank Corps battalion would be issued with 59 Light tanks. In numerical terms, the proposals under Memorandum No. 9 created a total unit requirement for 323 Light tanks, 86 Medium tanks, and 200 Infantry tanks. When unit reserves, war wastage and vehicles required for training schools were factored in, this requirement rose to 686 Light, 241 Medium and 565 Infantry tanks. The breakdown of these totals is shown in the table at the bottom of this page.

With a per item cost estimated to be £9,000 for either a Medium or Infantry tank, and £3,250 for a Light tank, this total requirement therefore came to just under £9.5 million, this rising to £12 million with the inclusion of 154 armoured cars and the spares and ancillaries required for all the aforementioned vehicles. By September the Matilda prototype was ready for delivery to the Mechanization Experimental Establishment (MEE) at Farnborough in Hampshire, this being the vehicle trials and testing facility operated by the Mechanization Board. On 14th September Alexander Davidson authorised performance and reliability trials to be conducted on the new machine, which was also intended to be demonstrated to the new Chief of the Imperial General Staff, Field Marshal Sir Cyril Deverell, the following month. As expected, the Matilda comprised a crew of two men, these being the commander–gunner and the driver. The hull was of comparatively simple construction and depended for its rigidity on the thickness of the plates employed. The side plates were all vertical, with both the nearside and offside plates being parallel up to the centre of the turret, from which point they tapered inwards to form the driver's compartment. The driver had a hood with a forward vision slit and vertically-opening hinged escape hatch, while in front of the hood was a downward sloping glacis plate which terminated at the nose plate. The hull belly (or floor) plate was stiffened by being longitudinally bent upwards to meet the side plate. The cylindrical cast one-man turret was supported on a horizontal roof plate, the engine compartment roof sloping downwards from behind the turret to meet the vertical rear plate. There were only two compartments within the vehicle, these being separated by a single transverse bulkhead. At the front was the combined fighting and driver's compartment, and at the rear was the combined engine and transmission compartment.

The Vickers-Horstmann suspension that had been sketched out by Carden and Studd had been eschewed in favour of the leaf-spring suspension taken from the Vickers Medium Dragon Mk. IV artillery tractor. This retained the proposed eight road wheels on each side of the vehicle, although the road wheel pairs were now grouped into two suspension units of four wheels each, the suspension units also incorporating a single return roller to guide the upper portion of the track. The positions of the drive sprockets and idler wheels had been swapped, as the machine was now driven from the rear, the idlers being positioned at the front, with the tracks also being from the Medium Dragon Mk. IV. The engine for the Matilda was the same 90 bhp (67 kW) 3.62 litre Ford 79F-6000BS V8 petrol engine as used in the Light Dragon Mk. III artillery tractor. This was colloquially known as the "flathead V8" after

Tank Type	Schools	Unit Equipment	Unit Reserves	Wastage Reserve
Light	40	323	113	210
Medium	20	86	36	99
Infantry	55	200	80	230



Cut away view of the Ford V8 Engine. On the Infantry Tank Mk. I the rear sloping engine compartment roof would necessitate the relocation of the air cleaner to the rear of the offside fuel tank. *(The Tank Museum)*

its flat cylinder head with sidevalve configuration, the design having been introduced in 1932 as the standard engine for use across the Ford Motor Company's entire range of commercial trucks and automobiles. Indeed, the engine fitted in the tank had been bought literally "off the shelf" from stocks available at the firm's works at Dagenham in Essex. The engine was longitudinally located in the centre of the engine compartment, with the fuel tanks being nestled on either side, these giving a range of approximately 60 miles (100 km) in mixed road and cross-country running. Cooling was via a standard Ford radiator and fan located at the front of the engine, while an external Still triple tube oil cooler had also been installed, this requiring a number of modifications to the cooling circuit that had needed approval from Fords. The reason for the addition of this cooler was to alleviate an issue that had been encountered on the Light Dragon Mk. III, on which the exhaust had been routed under the engine, thus heating and breaking down the oil in the sump.

Ventilation of the engine compartment was via a pair of inlet louvres in the roof plate just behind the turret and a corresponding pair of outlet louvres in the sloping roof of the engine compartment. The main component of the transmission was a standard commercial Fordson 68-7204 four-speed-and-reverse constant mesh gearbox, Fordson being the brand name for the Ford Motor Company's tractor and truck division. This was located behind the engine, and was driven from the engine by means of an eleven inch diameter single plate clutch. The gearbox offered four forward gears and one reverse, and drove an output cross shaft by means of a mitre gear, this being a type of bevel gear with a 1:1 ratio. The cross shaft incorporated the steering clutch and brake assemblies at each end, these being assembled from components that were already in use on the various Light tanks that were in service, including the new Light Tank Mk. VI. The output from each steering clutch and brake assembly was then fed through a planetary reduction gear, also of the Light tank type, to the final drive pinion, which engaged with the sprocket drive gearwheel and thus drove the tracks. On 18th September the Mechanization Board would authorise the Mechanization Experimental Establishment to commence its testing under the official designation of "Tank, Infantry, A.11.E.1". The subsequent trials were stipulated to comprise 800 miles (1300 km) of cross-country running and 200 miles (300 km) of road work.

The arrival of the completed Matilda had prompted Elles to ponder a more ambitious derivative, and so on 7th September the Director of Mechanization, Alexander Davidson, issued a memorandum pronouncing that "M.G.O. wishes an investigation to be made into the possibility of producing a 3-man tank somewhat similar to Matilda, with 50 mm. plate, but with a top speed of 10 – 15 miles per hour [16 – 24 km/h]." Davidson furthermore underlined that "It is important that this vehicle should have ample reserve of power to enable it to maintain high average speeds even though its top speed should not exceed the limits given above."

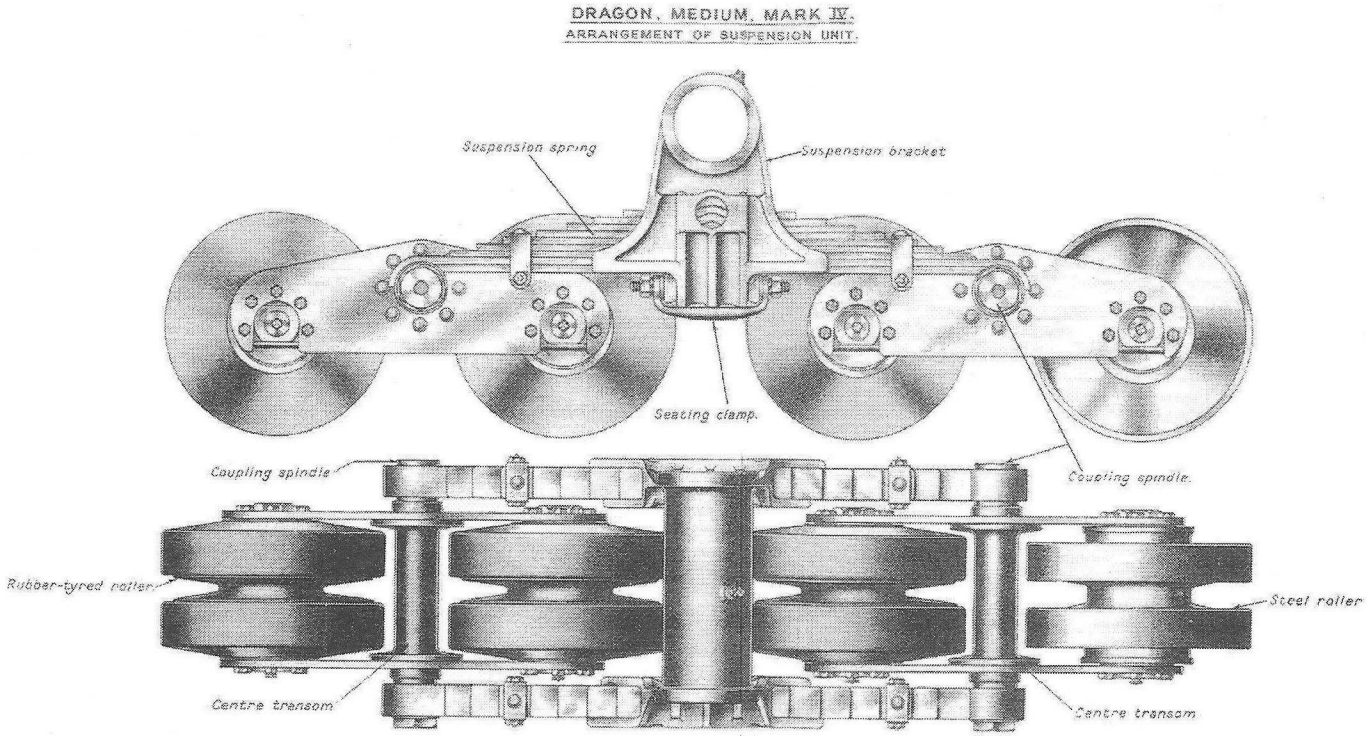


Diagram of the rear suspension unit of the Dragon Mk. IV with a single steel-rimmed wheel. On the Infantry Tank Mk. I, the last pair of wheels would be of the steel-rimmed type.

Two armament possibilities were to be considered for the new tank, these being either a 2 pounder gun and 0.303-in. machine gun mounted co-axially, or two machine guns, these also being mounted co-axially. Unlike the Matilda, a wireless set would be required, while a diesel engine was preferred to a petrol engine.

Davidson noted that a "Single engine is desired", this of course referencing the fact that the larger tanks currently in development were reliant on twin engines, and stipulated that "The investigation should indicate the horse power which is likely to be required for the engine, approximate size and approximate weight." The weight of the engine (or engines) was a potentially significant factor, as "It is desirable that the tank should be able to cross a floating bridge of capacity 14 tons, so in dealing with alternatives, it should be indicated which are likely to cause 14 ton weight to be exceeded and which are not." Otherwise, the Director of Mechanization advanced that "It is unnecessary to go into details of the transmission or suspension at this stage, as it is only desired at the moment to ascertain the bare outlines of a machine as detailed above, based largely on an expansion of Matilda." Davidson mandated that the investigation into the new machine be conducted by the Mechanization Board rather than the Superintendent of Design's 'M' section, thus keeping it out of the purview of E.M.C. Clarke, who was hostile to the concept of the Infantry tank. Davidson's deputy, 'Q' Martel, was at this time observing the Soviet Red Army on manoeuvres in the White Russian (Belorussian) Military District, in the vicinity of the city of Minsk, as part of a British Military Mission under Major-General Archibald Wavell. During the four days of the manoeuvres, from the 8th to the 11th of September, the visiting delegates would be "out on the ground" with the participating formations, which comprised six infantry divisions, four cavalry divisions, and six brigades of mechanised troops, while seven "brigades" of aircraft were employed overhead. Of the various Soviet tank models that he had observed, Martel was most taken with the BT series, these being fast moving tanks capable of achieving over 30 mph (50 km/h) that had been adapted from a design by the American engineer J. Walter Christie. The BT tanks featured four large road wheels per side with long travel suspension units, these allowing them to traverse undulating ground without varying their speed or changing gear. They were powered by a single 350 hp (260 kW) Liberty aero engine, and were armoured to a similar standard as Vickers' A9 tank, although Martel observed that the performance of the BT tanks far outstripped that of the A9.

On 15th September Martel would dash off letters to Alexander Davidson and Hugh Elles, extolling what he had seen and urging the purchase of a BT chassis from the Soviets. In the event, Martel would elect to deal with Christie himself, albeit through the firm of Morris Commercial Cars Ltd., with Martel's deputy John Scott Crawford handling the initial negotiations. Subsequently on 12th October Martel requested financial sanction to purchase two Christie tanks from America at an estimated cost of £16,000, his intention being to develop a "cruiser" tank derivative utilising a standard British turret and armament. As a consequence, Martel and Davidson were effectively going in entirely different conceptual directions in tank development, with Davidson's nominally superior rank counting for little in the face of Martel's drive and ambition. On 19th October the minister in charge of the War Office, Alfred Duff Cooper, the Secretary of State for War, would compose a *Memorandum on the Tank Situation* for the sub-committee on Defence Policy Requirements of the Committee of Imperial Defence. Within his memorandum, Duff Cooper would explain that there were now four types of tank that were considered necessary for equipping the Army, these being the existing Light and Medium types, and the new Cruiser and Infantry tanks. As far as the latter was concerned, he announced that "an experimental model has now been delivered and is undergoing trials", and that "Some features of this tank constitute, we believe, a great advance in tank design, and may solve the problem of providing adequate armour for assault tanks, which has baffled both ourselves and other nations until now." He further submitted that the Matilda "gives every hope of adoption as a first model", and that "If this tank justifies our going to production at once, delivery should start by the end of 1937." The Secretary of State nonetheless cautioned that:

> It cannot be said, however, that this type of tank is necessarily the ideal infantry tank. Its speed is not as great as we should like and its crew at present consists of only two men. Whether a three-man tank of similar design, with greater speed, but at the same time not too conspicuous, is a possibility, remains to be seen. In any case, even if we go to production with the present model immediately, it will be necessary to try to improve the design.

Although War Office Memorandum No. 9 had posited a need for 200 Infantry tanks, the scope for rearmament had shifted considerably since May, with Duff Cooper now announcing that "Our requirements in infantry tanks, including reserves, will be approximately 680 to start with." One option that was being considered for quickly building up the pool of available tanks was to source them from overseas, although the Secretary of State claimed that:

> The purchase of tanks in bulk from abroad has been considered but it presents difficulties. Not only

are foreign countries very averse to showing their latest pattern of tank, and still more averse to selling them, but also the supply of spares etc. in time of war would be precarious. Moreover, if we purchase abroad, education in tank design in this country is proportionately reduced.

He therefore advocated that "For these reasons the purchase of models from abroad for improvement and adaptation is a more desirable course to pursue." This would effectively mean modifying foreign designs for manufacture in the United Kingdom, this of course being the course that 'Q' Martel was pursuing with the Cruiser tank. Duff Cooper would present his memorandum at the subsequent Defence Policy Requirements committee meeting, this being attended by the CIGS, Cyril Deverell, as well as Vice-Admiral Sir Harold Brown, the War Office's Director-General of Munitions Production (DGMP). Also among the attendees were the Secretary of State for Air, Lord Swinton, and his advisor the Scottish industrialist Lord William Weir, as well as Sir Richard Hopkins of the Treasury. The discussion on tanks during the meeting was of a very general nature, the main theme being the need to increase the number of firms able to design and produce tanks, as the requisite skills were currently only possessed by Vickers-Armstrongs. This was becoming an increasingly pressing issue, as Deverell pointed out that the War Office would require a greater number of tanks than was originally forecast. The CIGS did however echo Duff Cooper in predicting that "Infantry tanks would shortly it was hoped come into production, and deliveries would start at the end of next year."

MEE report A45 on the preliminary performance trials of A11E1 was issued on the 27th October 1936, this detailing that by 15th October the machine had covered 541 miles (871 km), although 40 (64 km) of these had been clocked up by Vickers at Chertsey prior to delivery. Of the 501 miles (806 km) accrued at Farnborough, 465 (749 km) had been run across country and only 36 (58 km) on road. A11E1 had originally had its engine governed to give a maximum road speed of

A11E1 as delivered to the MEE at Farnborough in September 1936. Note the toothed front idler wheels and slots for the track adjusting tool. The drive sprockets are in the original low position, while the driver's visor plate is a wooden mock-up with an inadequate vision slit. The visor, glacis and nose plates are bolted in position, and the nose plate outriggers for mounting the idler wheels are bowed forwards, the only external stowage being the track adjusting tool. No headlamps or driver's periscope are fitted, the turret being of the 60 mm armour basis type with prominent frontal brow. *(Cambridge University Library)*

5½ mph (9 km/h)due to concerns at Chertsey as to the durability of the engine in such a comparatively heavy vehicle, although after 341 miles (549 km) the governing was deactivated and the remaining 160 miles (258 km) run with the engine ungoverned in order to gauge the efficacy of the Still oil cooler. During the total mileage period the tank had been driven at a gross weight of 10.32 tons, this including the two crew members and ballasting to represent the full service stowage, the weight of the unladen tank with full petrol and oil tanks being 9.65 tons. Report A45 noted that the standard service lubricant M600 was employed in the final drives, and in the bevel gear outputs from the gearbox, while commercial Texaco Crater oil was used in the planetary reduction gears. The engine and gearbox also used a commercial lubricating oil, this being Castrol XL by C.C. Wakefield Ltd. A preliminary examination had been made of the design of the vehicle, it being remarked that its small size made it inconspicuous. The driver's hood had been fitted with a temporary wooden mock-up of its front plate, whose viewing slit gave inadequate vision, although the driver's field of view when the hood was opened up was assessed as very good. The turret hatch was thought to be heavy to open and close, although it did provide the commander with a means of looking out, it being noted that neither the driver nor commander had been provided with a periscope. For the driver's position it was attested that "The driver's accommodation is reasonably comfortable for a small man with the exception of the fuse box, which fouls the left knee", and so "This should be repositioned." The driver's controls were adjudged to be adequate to use and accessible to adjust, while the ventilation throughout the fighting compartment was viewed as being satisfactory. Steering was via a pair of steering levers, one on each side of the driver, with each lever operating the appropriate steering clutch when pulled rearwards, this giving a gentle "radius" turn. Further application of the lever would actuate the requisite steering brake, thus giving a sharper "skid" turn. A foot brake was also provided in order to directly operate both steering brakes simultaneously, this being adjacent to the engine clutch pedal.

The driver was provided with a single festoon lamp for illuminating the engine temperature and oil pressure gauges, it being ventured that "An extra lamp is desirable for the other instruments." It was also advanced that some form of internal lighting would be necessary for the turret, while the two side lamps that comprised the external lighting were deemed to be "adequate for the low speeds of which the vehicle is capable." The offside side lamp also housed an electrically operated horn, which was considered to be satisfactory in its operation. The MEE had fitted a temporary rearview mirror on the support strut for the offside idler wheel, it being admitted that this was "A vulnerable position, but there appears to be no alternative." It was found that the turret was easy to turn, although "Rotation is very slow owing to the low gear", it also being submitted that "It is understood that the turret is not now in its final form." The traverse was by hand-operated gear only, with no power traverse being provided, while it was indeed the case that the turret fitted to A11E1 was a one-off design that was not intended for production. The fire precautions were for the A11E1 were considered to be acceptable, there being a pair of "pyrene" fire extinguishers stowed within the vehicle, and another pair carried externally on the idler wheel support struts. The towing arrangements consisted of a pair of towing eyes at the front of the vehicle and another pair at the rear, it being appraised that "The towing eyes are suitably placed for lifting or towing and are sufficiently robust for the purpose." No trackguards were provided, this having certain advantages as it was noted that "Accessibility to all parts of the hull is satisfactory." On the subject of the Ford engine, it was relayed that "The general arrangement of the cooling, including fan belt adjustment is satisfactory." Most of the engine accessories were easily accessed, with the exception of the distributors for the ignition system, which were awkwardly located between the engine and the radiator, below the fan. It was also averred that the dipstick had to be bent in order for it to be removed, while the filler for the lubricating oil was sufficiently restricted as to only allow the oil to pass through it very slowly. The report also advised that the cover on the engine compartment roof plate above the Zenith carburettor be hinged to improve access to it. The fuel system was found to be free of leaks, both petrol tanks having drain plugs that were accessible from under the vehicle, via cover plates in the hull belly plate. For the engine cooling system, it was observed that the pressure relief valve for the radiator was set to open at 4 lbf/in^2 (27.5 kPa), with the temperature being measured from the radiator header pipe. A water drain tap was situated at the bottom of each of the two engine cylinder blocks, while a pair of attachable "blanking boards" (*i.e.* blanking plates) were provided for the ventilation inlets on the roof behind the turret in order to help maintain the temperature in the engine compartment in cold ambient conditions. Two defects had been encountered with the engine, the first of these being a petrol stoppage at 286 miles (460 km) due to the flexible petrol pipe from the tanks to the filter, this being replaced by a pipe of a different type provided by Vickers at Chertsey. The second engine defect was the breaking of both fan belts at 478 miles (770 km), these being replaced with new ones. For the transmission it was observed that:

> Accessibility throughout the transmission is not good. The hand adjustment for the steering brakes

Offside view of A11E1 as initially configured. This gives a good view of the low position of the driver sprockets and the brackets for the return rollers, whose brackets are mounted on the same axles as the suspension brackets. (Cambridge University Library)

is accessible but it is considered that practically the whole rear top plate should be made to hinge open instead of the very small doors now provided. The cowling on the brakes should be made quickly detachable. The whole assembly of bevel box, steering clutches, and primary reductions can be easily removed as a complete assembly for major repairs.

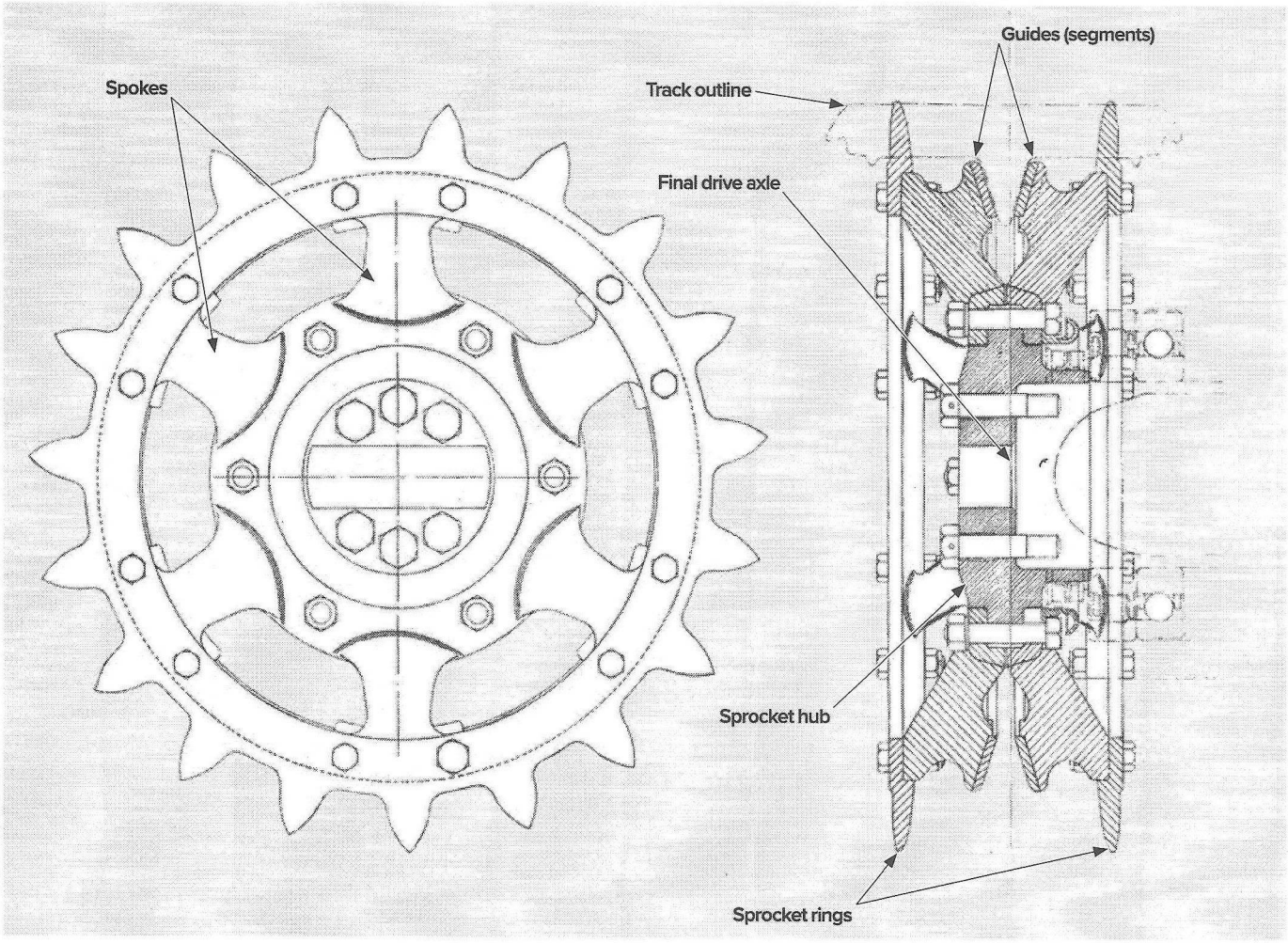
The "primary reductions" referred to here were the planetary reduction gears between the steering clutches and the final drives. At 541 miles (871 km) the nearside steering brake drum was found to be floating sideways, so at 566 miles (911 km) the complete steering assembly was removed and sent to Chertsey for inspection and repair. It was found that the nearside brake lining was worn out, although the offside lining was still in good condition. It had also been discovered that the planetary reduction gears needed topping up with oil approximately every 50 miles (80 km), owing to excessive leakage from their split oil casings (or "bell housings"), the report disclosing that "It is understood that the makers intend to modify this on later models." The suspension was found to have good accessibility, although it was acknowledged that "No shock absorbers are provided". The tank's performance on smooth roads was accredited as being "Very satisfactory", whereas on two cross country courses (No. 11 and No. 12) it was adjudged as being satisfactory, as "Little pitching takes place but suspension is harsh at speeds of 10 m.p.h. [16 km/h]" These courses had obviously been negotiated with the engine ungoverned, as had a short course of railway sleepers that consisted of a single sleeper followed by a raised platform made from sleepers laid adjacently. This was taken by A11E1 at both 7 mph and 11½ mph (11 and 18.5 km/h), in order to gauge the degree of pitching, which was the tendency of the vehicle to rock forwards and backwards when encountering an obstacle. During first three runs over this course, at 7 mph (11 km/h), the highest angle of

pitching upwards over the single sleeper was 3.75°, and the deepest angle of pitching downwards was 4.05°. When driving onto the raised platform, the maximum pitch was 4.75° upwards, and when driving off the platform it was 5.8° downwards. For the two runs conducted at approximately 11½ mph (18.5 km/h), the maximum angles of pitching over the single sleeper were +3.65° and −3°, while over the raised platform these were +6.6° and −5.6°. In all cases the pitching attenuated quickly with only two or at most three undulations. A single suspension defect had been experienced during the mileage so far accrued, as a new nearside return roller had to be fitted at 495 miles (797 km), due to its tyre having become detached from the rim. For the tracks it was commented that:

> Up to 495 miles [797 km], 57 track pins have been broken and replaced, and 3 plates changed due to twisting through broken pins coming half way out. At this mileage, a set of segments were placed on the inside of the sprocket teeth, similar to those already on the outside. Since then, one pin only has been broken, at mileage of 541 [871 km].

The "segments" were actually guides located within the two rings of the sprocket wheel, with each guide being assembled from a number of segments. The purpose of these guides was to straighten the track by providing a trough for the track guides, which were the vertical portions of the track links that guided them between the twin discs of the road and idler wheels. It would appear that initially only one such guide had been fitted, adjacent to the outer sprocket ring, and this had then been complemented by another one fitted to the inner sprocket ring. The sprocket rings were detachable components as their tendency to wear necessitated their regular replacement, being fixed to their hubs by means of twelve bolts and locking nuts. Prior to running each track had had 115 links, these being of the 3.5 in. (89 mm) pitch cast iron "tractor" type, and over 478 miles (770 km) the pitch of each link had increased by 1.94%, while the weight of each link had decreased by 1.44% (from 7.64 to 7.53 lbs./3.47 kg to 3.42 kg). It was further observed that:

Diagram of the A11 sprocket wheel assembly. Both the sprocket rings and guide segments could be removed and replaced when worn, a pair of rings being expected to endure for as long as a track. *(The Tank Museum)*



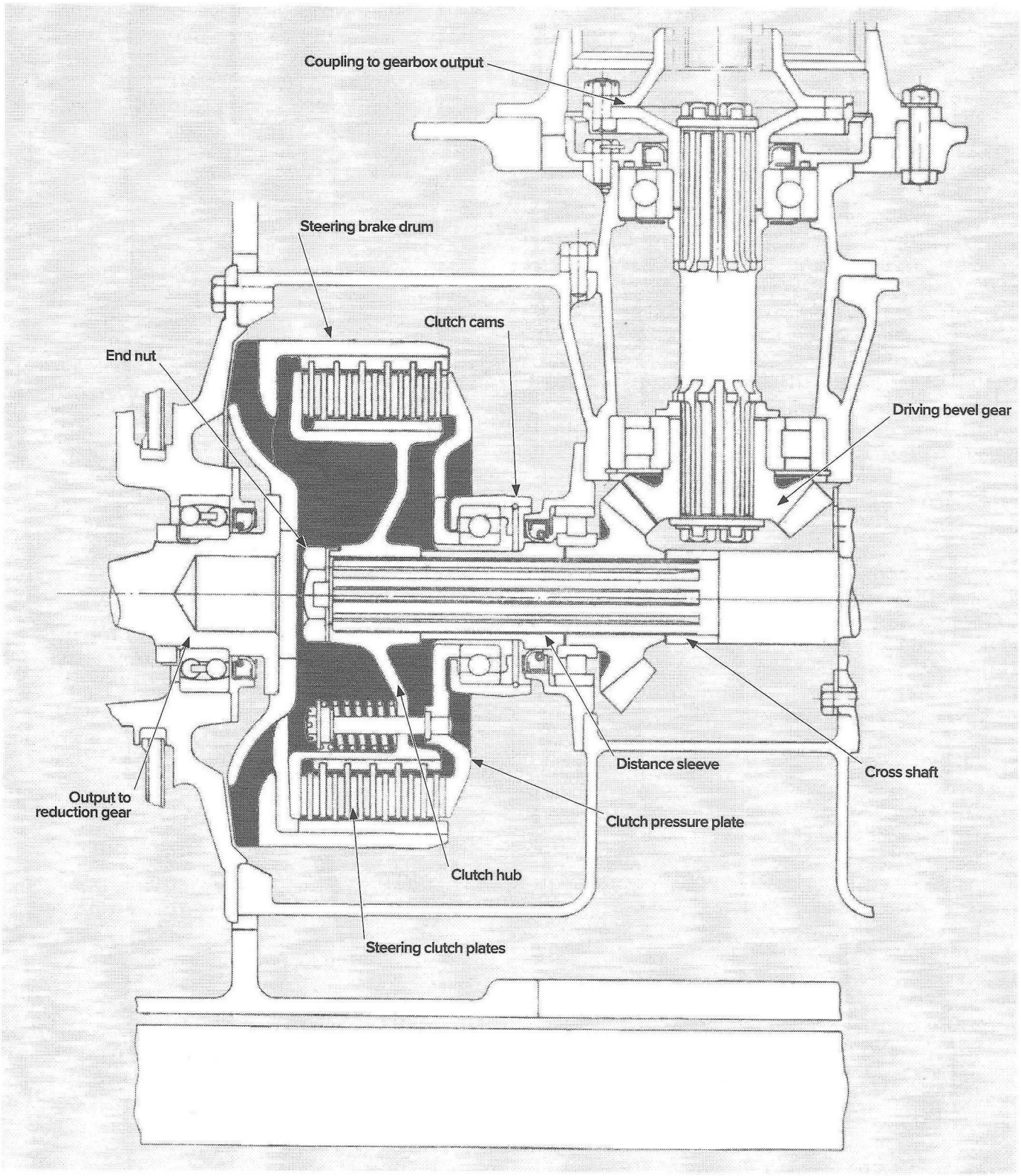


Diagram of the nearside steering unit. On the driver pulling back his steering lever the clutch cams would be actuated, disengaging the clutch and allowing the driver sprocket to freewheel, thus inducing a radius turn. On the steering lever being pulled back fully, a lever assembly would operate the brake bands, which would engage the outer brake drum surface, inducing a more sudden skid turn. *(The Tank Museum)*

> Track adjustment is by an eccentric on the idler wheel mounting held by a pawl and ratchet. Operation is satisfactory, but a positive locking device is considered advisable.

The lack of positive locking for the pawl of the track adjusting ratchet wheel had meant that "On one occasion, during tests, when the machine bumped badly, the track adjustment tightened itself up." The cranked axles for both the front idler wheels had also become bent, allowing the idlers to splay out slightly, the report noting that "The machine has been pulling to the offside for the last 100 miles [160 km], due to the bending of the idler spindle. Fairly frequent adjustment of the near-side steering brake bands was, therefore, needed." The "idler spindle" referenced here was the cranked axle on which the idler wheel was mounted, the crank allowing it to be swung for adjustment. As far as the performance of A11E1 was concerned, over a quarter-mile (400 m) cross country course an average speed of 5.8 mph (9.3 km/h) was achieved with the engine governed, and an average of 10.9 mph (17.5 km.h) attained with the engine ungoverned. Over a longer two mile (3 km) cross country circuit, an average of 5.6 mph (9.0 km/h) was achieved with the engine governed, while a 22 mile (35 km) road circuit was completed at an average of 5.17 mph (8.32 km/h), it being recognised that "Up to speeds of which the vehicle is capable the power of manoeuvre and the control on roads or across country is satisfactory." Regarding A11E1's gradient performance, there was no 35° slope available in order to confirm whether it met the specification, but it was confirmed that it could restart in 1st gear on a slope of 24.7°, and climb a slope of 18.7° in 2nd gear. Beacon Hill, with a gradient of 1 to 10.45, was climbed at 3.9 mph (6.3 km/h) in third and fourth gears with the engine governed, it being noted that when travelling downhill "Owing to the slow speed, no reversal of steering has been experienced". Reverse steering was the tendency for the tank's own momentum, for example when travelling downhill, to cause it to steer in the opposite direction when the steering clutch was released, this potentially occurring during the pause between the release of the steering clutch and the application of the steering brake. A stopping test had been conducted at approximately 8 mph (13 km/h), with the following decelerations being the average of three runs:

	Dry Road	**Wet Road**
Steering Brakes Only	11.92 ft./sec^2 (3.633 m/s^2)	9.8 ft./sec^2 (3.0 m/s^2)
Foot Brake Only	4.65 ft./sec^2 (1.42 m/s^2)	3.98 ft./sec^2 (1.21 m/s^2)

The steering brakes would have retarded the vehicle when the driver pulled both back simultaneously, although this would not have been an approved stopping method in service. The rolling resistance on a tarmac road was measured as 800 lbs. (360 kg), this being equivalent to 77.5 lbs. (345 N) per ton, while on dry, firm, level grassland the rolling resistance was 1466 lbs. (665.0 kg), or 142 lbs. (632 N) per ton. The towing eyes had been utilised for a drawbar pull test in order to gauge the effectiveness of A11E1 for salvage work, it being able to pull 21,300 lbs. (9,660 kg) on dry level grassland, this being equivalent to 2065 lbs. (936.7 kg) per ton. The limiting factor in this instance was engine stall, though on a dry, level tarmac road A11E1 was only capable of pulling 14,800 lbs. (1434 lbs. per ton; 6710 kg, or 650.5 kg/ton) due to its tracks slipping on the road surface. The tank crossed a 6 ft. 6 in. (2.0 m) trench with ease, with further tests being planned to find its maximum capacity, it also being declared that "It will climb a vertical obstacle of 2 ft. 7½ in. [80 cm] easily." Overall, it was adjudged that "The high clearance, low centre of gravity, and length of track on ground, combine to give a very satisfactory obstacle crossing capacity." Fuel consumption for the governed engine was 2 mpg (0.85 km/l) on road and 1.8 mpg (0.77 km/l) cross country, while for the oil consumption it was related that:

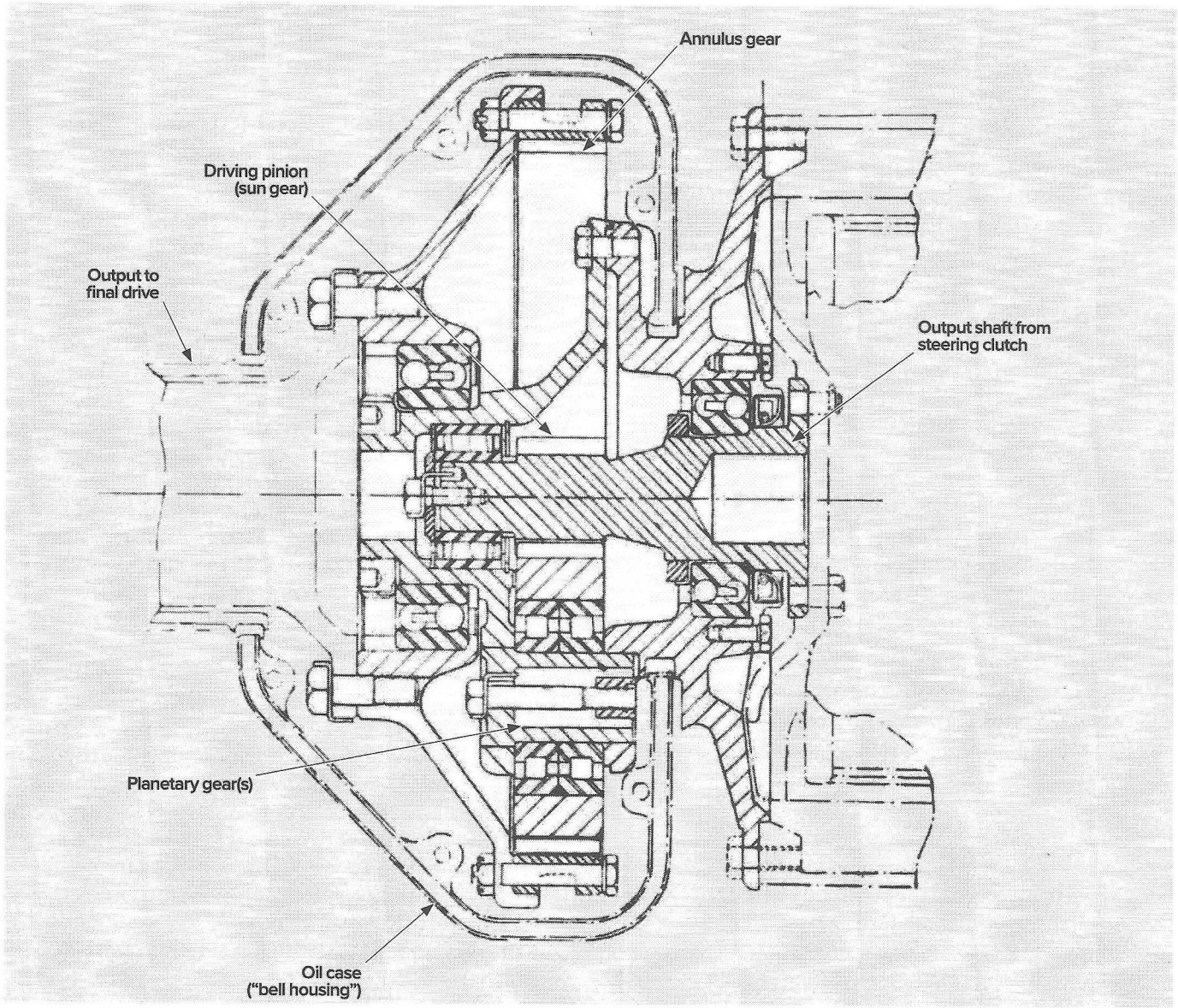
> Over first 400 miles [640 km] [this] was Nil, except for changes of oil. At 540 miles [870 km] it is approximately 500 m.p.g. [200 km/l] including slight loss through leaks in oil cooler connection. Four oil samples have been taken and sent to W.D. Chemist and Messrs. Ford, Ltd. for analysis.

The oil samples were being checked by the War Department (*i.e.* the War Office and its establishments) and Fords in order to assess whether the period between oil changes could be extended. With regard to the engine cooling, tests were carried out with both the oil cooler fitted and with it removed, the engine being governed at all times. Over the two mile cross country circuit, this yielded a maximum sump oil temperature difference (TD) over ambient of 112 °F (44 °C) with the cooler fitted and 124 °F (51 °C) with it removed, while the TD within the cooler itself was 97 °F (36 °C). The cooling water temperature differences were 109 °F (43 °C) with the oil cooler fitted and 110 °F with it removed. Over the 22 mile (35 km) road run, with the oil cooler removed, the sump oil TD was 119 °F (48 °C) and the cooling water TD was 106 °F (41 °C), the report noting that one of the two blanking boards had been fitted to the ventilation inlets behind the turret during the first 2½ miles (4 km), in order to prevent over-cooling. Following the cooling trials, two external baffles had been fitted on the engine compartment roof, one between the ventilating inlet louvres, and the other between the outlet louvres, these presumably being to attenuate

any noise originating from within the engine compartment itself. A couple of modifications had also been implemented, one of these being the enlargement of the hole in the hull belly plate beneath the engine sump, to better facilitate the removal of its drain plug. The other alteration was to the bulkhead between the engine and fighting compartments, which had been modified to allow the removal of the radiator without interference to the floor plate. It was recorded that it took two hours to remove the radiator with two men working, this comparing with the five hours it took three men to remove the radiator along with the complete engine and gearbox. The steering assembly took 2½ hours to remove, again with three men working on it. Finally, the report asserted that following the return of the repaired steering assembly from Vickers-Armstrongs, running would continue with A11E1 governed to 8 mph (13 km/h).

On the afternoon of 30th October Hugh Elles was visited at the War Office by Sir Noel Birch, who was the joint head of Vickers' sales organisation based at Vickers House in Westminster, London. Birch would write a short account of the meeting, in which he recapitulated that "The M.G.O. said that he has again changed his mind about tanks and now thinks that instead of them being useless owing to anti-tank guns, rifles, mines, etc. they will still be of some good to the Army but that they will occupy a secondary position to what they have done in the past." Elles had outlined that the 'M' section at Woolwich Arsenal were working on a tank on a 14 mm basis (A7E3), and that

The reduction gear assembly, in which the output shaft drive pinion (or sun gear) drove an outer annular gear via three fixed planetary gears. This minimal diagram does not depict the teeth on the inner face of the annulus gear, the instruction book for the Infantry Tank Mk. I being a rather perfunctory effort. (The Tank Museum)



he wanted greater competition in tank design, with William Morris (Lord Nuffield) and his firm Morris Commercial Cars being involved in the sourcing of the Christie tanks. Birch noted that "Nuffield is quite prepared to design tanks but he is rather shying about the bullet proof plate", this reflecting the fact that unlike Vickers, who owned the English Steel Corporation, the Nuffield group of companies did not include a steelworks. He further recounted that "The M.G.O. has also approached the Vulcan Company with a view to their making a very heavily armoured tank, an improvement on our Matilda." In fact, it is likely that it was Alexander Davidson who had made the approach to the Vulcan Foundry, at Newton-le-Willows in Lancashire, as he had served his apprenticeship there. A demonstration of the latest tank prototypes had been arranged for 2nd November for the benefit of the Cabinet, during which A11E1 was to be demonstrated alongside A9E1 and one of the current service Vickers Medium Tanks, as well as various ancillary AFV's, with Birch mentioning that:

> At Monday's show he [*i.e.* Elles] hopes that besides Duff Cooper and Inskip, Swinton, Sam Hoare and several others will be there. The M.G.O. told me that his own idea about tanks was that he wanted two of a much heavier sort than we had now, one with 30 m/m and one with 60 m/m, and he hoped to have definite news in this respect by the end of November.

Sir Samuel Hoare was the First Lord of the Admiralty, while Thomas Inskip was the Minister for Co-ordination of Defence, who effectively oversaw rearmament policy across all three services. While Sir Noel Birch had been talking to Hugh Elles at the War Office one of his technical experts, Captain A.J. Nannini, had been paying a visit to Woolwich Arsenal, where he learned that:

> Hitherto the War Office have been content to specify that tank armour should keep out armour piercing bullets of rifle calibre, but it is now agreed that protection against high velocity ·5" [12.7 mm], and the Continental ·8" [20 mm] ammunition, must be provided, and with this in view the M.G.O. has expressed the opinion that medium tanks should carry 30 m/m of armour.

It had accordingly been suggested that the 14 mm armour of the A7E3 be augmented, as "Woolwich have been asked to investigate the possibility of re-armouring the Arsenal experimental tank A.7., on the basis of 30 m/m., but they are finding it impossible to do more than a good basic 25 m/m, which they hope will only result in the loss of 2 or 3 m.p.h. [3 to 5 km/h] speed." This of course would provide equivalent protection to that originally specified for A10E1, demonstrating that what was once deemed necessary for an assault tank was now felt required for a standard Medium tank. E.M.C. Clarke, who was still directing design at Woolwich, had apparently been consulted as Nannini reported that "It appears to be generally accepted that the tank should not normally be used for the direct attack of prepared defences, as it is generally understood that it will always be possible to produce an anti-tank gun capable of defeating the tank." The reasoning behind this view was that "As tank armour increases, gun calibre and velocity will be increased, and it can be safely said that the cost of the anti-tank gun will usually be less than one quarter the cost of the tank which it can destroy, and this figure also indicates the ease of rapid production of suitable anti-tank guns as compared with tanks." Although this rationale was plausible for the medium term, there would eventually come a point where guns would become too large to manhandle. Nonetheless, this reasoning added to the scepticism towards the Infantry tank concept, as:

> General Ironside considers that the idea of the infantry advancing to the attack in the wake of heavy tanks capable of breaking down prepared defences is nonsense, and that the tactics governing employment of tanks and infantry need to be entirely changed.
>
> In this view he has the support of many senior officers, but unfortunately it is not yet the officially accepted view — hence the difficulty of determining the legitimate role of heavy and medium tanks.

General Edmund Ironside was the commander of Home Forces' Eastern Command, and was a particularly experienced and respected figure, his views being symptomatic of the rising level of disquiet being generated by Hugh Elles' ideas. As Elles wanted two tanks, of which one had a 30 mm armour basis and the other 60 mm, it would appear that the MGO was considering both the A7E3 and A10E1 as the potential 30 mm armoured tank, and the larger Infantry tank being overseen by Alexander Davidson as the 60 mm armoured tank. However this latter vehicle, which was originally posited to have an armour basis of 50 mm, had in fact had its proposed armour augmented to 70 mm by the Mechanization Board. On 10th November the War Office issued their Memorandum No. 57 for submission to the TISC, which called for an increase in the number of tanks that would be deployed by the Field Force. This was prompted partly by the accelerating pace of tank development on the Continent, partly by the decision to proceed with the creation of the Mobile Division, and partly by proposed revisions to the

war establishments of the various types of tank unit, the memorandum stating that:

> At the time that Memorandum No. 9 was produced the detailed composition of a Field Force had not yet been fully worked out and the war establishments of many units had not been decided. Some of these establishments are still only provisional and will not be firm until further experiments have been carried out.

The composition of the Mobile Division had been revised to include two permanent brigades each containing two mechanized cavalry regiments equipped with Light tanks and one motor infantry battalion. There was also an intention to make the Tank Brigade a semi-autonomous component of the Mobile Division, although this initiative was still under debate. Outside the Mobile Division, it was now proposed to mechanize a total of four horsed divisional cavalry regiments, these also to be equipped with Light tanks. Extraneous to the Field Force, it was further intended to mechanize the three cavalry regiments currently in the Middle East to form "The Mobile Force (Egypt)", with two regiments being equipped with Light Tanks and the third with armoured cars. Although the new proposals meant that the number of mechanized Cavalry regiments had risen from the two advocated in Memorandum No. 9 to a total of ten, the Royal Tank Corps requirements for three Mixed Tank Battalions, four Army Tank Battalions, and a single Tank Brigade Headquarters remained the same. However, there would be an alteration to their establishments, as:

> The new proposals envisage a new pattern of Tank to take the place of the present Light Tank in units of the Tank Brigade. This new pattern is called a 'Cruiser' Tank, and the present Mark VI Light Tank will be confined to converted Cavalry Regiments, the number of which to be equipped with tanks has risen to 10 of which one will replace one of the two R.T.C. Light Tank battalions"

As a result, the 23 Light tanks of each Mixed Tank Battalion, and the 4 Light tanks of the 1st Tank Brigade headquarters would be replaced by equal numbers of Cruiser tanks. The number of proposed RTC light tank battalions would be reduced from two to one, although its 59 Light tanks would be entirely replaced by Cruisers. This would continue to be the 1st (Light) Battalion RTC, which would return to the 1st Tank Brigade, with the 4th Battalion being earmarked to become an Army Tank battalion once the Infantry tanks became available. Each Army Tank battalion would be considerably augmented, their allocation of Infantry tanks being increased from 50 to 60, while 15 Medium tanks would now be included in these units, the existing 4 Light tanks being retained. The addition of the Medium tanks was likely to have been to engage any interfering enemy tanks, as the A11 was only armed with a single machine gun. The provisions of Memorandum No. 57 thus implied a revised total unit requirement of 132 Cruisers, 146 Medium, 240 Infantry and 596 Light tanks. Including tanks for schools, unit reserves, and war wastage, this necessitated a requirement for 350 Cruiser, 159 Medium, 115 Infantry and 650 Light tanks above and beyond those laid out in War Office Memorandum No. 9. The full requirement was now therefore:

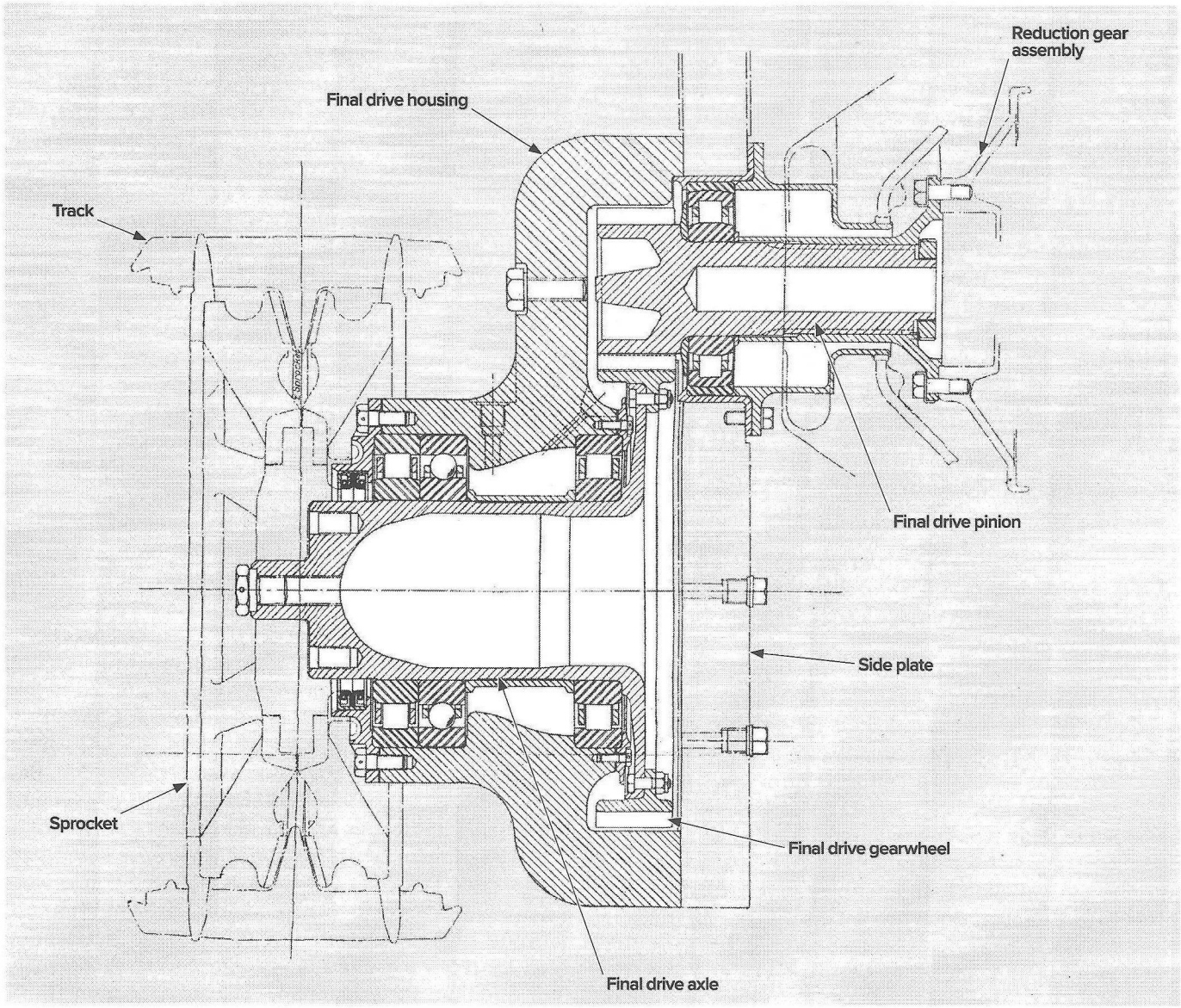
Light Tanks	1336
Cruiser Tanks	350
Medium Tanks	400
Infantry Tanks	680

With Cruisers expected to cost around £7,000 each, and the estimated price of a Medium tank having risen to £13,000, this induced an additional cost of £8,628,500, although this sum would rise further to £9,928,500 with the incorporation of spares. It should be noted that these costs only covered the vehicles themselves, and did not cover armament, ammunition and wireless sets, which would incur an extra £1,843,000 for a final total of £11,771,500. Memorandum No. 57 surmised that "It is not anticipated that the programme will give rise to any insuperable difficulties from the production point of view, provided that designs are settled in time to allow a reasonable period for manufacture." However, it was anticipated that there was likely to be a substantial initial expenditure on plant, especially for producing bullet proof (*i.e.* armour) plate, for which a financial estimate could not yet be given. On the other hand, it was submitted that expenditure on reserves could be mitigated prior to 31st March 1939, as it was anticipated that the level of production achieved from that date onwards would be sufficient to make good any unit losses suffered (*i.e.* war wastage) if a war were to have commenced before then. In essence, this was a proposal to discount the need to provide war wastage reserves until production capacity was sufficiently enhanced to meet that requirement. War Office Memorandum No. 57 was submitted to the 45th Meeting of the Treasury Inter-Service Committee on 13th November by Kenneth Lyon, the Assistant Under Secretary of State for War representing the War Office's Department of Finance. In presenting the revised proposals for tank allocations, Lyon emphasized that these did not involve any increase in the size of the Field Force, as they only implied the conversion of existing units (*e.g.* by mechanizing existing "horsed" Cavalry regiments), and revisions to unit equipment (*e.g.* by replacing Light tanks with Cruisers). As such, the addition of 15 Medium tanks to the Army Tank

Battalions would be covered by the cancellation of the 1st Tank Brigade's second light tank battalion. On considering the production situation, the Committee observed that it was only the Light tanks that were currently in production. In response, the War Office's Director of Staff Duties (DSD), Major-General Ernest Squires, conceded that orders could not currently be placed for any completed design except for the Light tanks, so he suggested that in the meantime orders might be placed for the armour plate for all the various types. Kenneth Lyon in turn added that this would constitute progress in production planning by reserving factory capacity, and undertook to supply the Treasury with a breakdown of the revised programme, and its anticipated costs, into unit equipment, unit reserves, and war wastage. Edward Bridges of the Treasury referred to Alfred Duff Cooper's Memorandum on the Tank Situation, in which the Secretary of State for War had emphasized the rapid obsolescence of tank types and the consequent need for "a heavy replacement programme from time to time." Bridges thus enquired as to the extent it was possible to go into production on smaller volumes than the total requirements laid down in Memorandum No. 57. To this, Lyon simply replied that production had to be planned in large batches. The minutes of the Meeting recorded that:

> Major General Squires said that in view of the deficiencies of the Field Force the time had now come when production must be planned on the basis of the types already evolved. He did not think that a reduction in the numbers produced could be made except in so far as it might be possible to

Diagram of the final drive assembly, this providing another reduction in gear from the dedicated reduction gear assembly. *(The Tank Museum)*



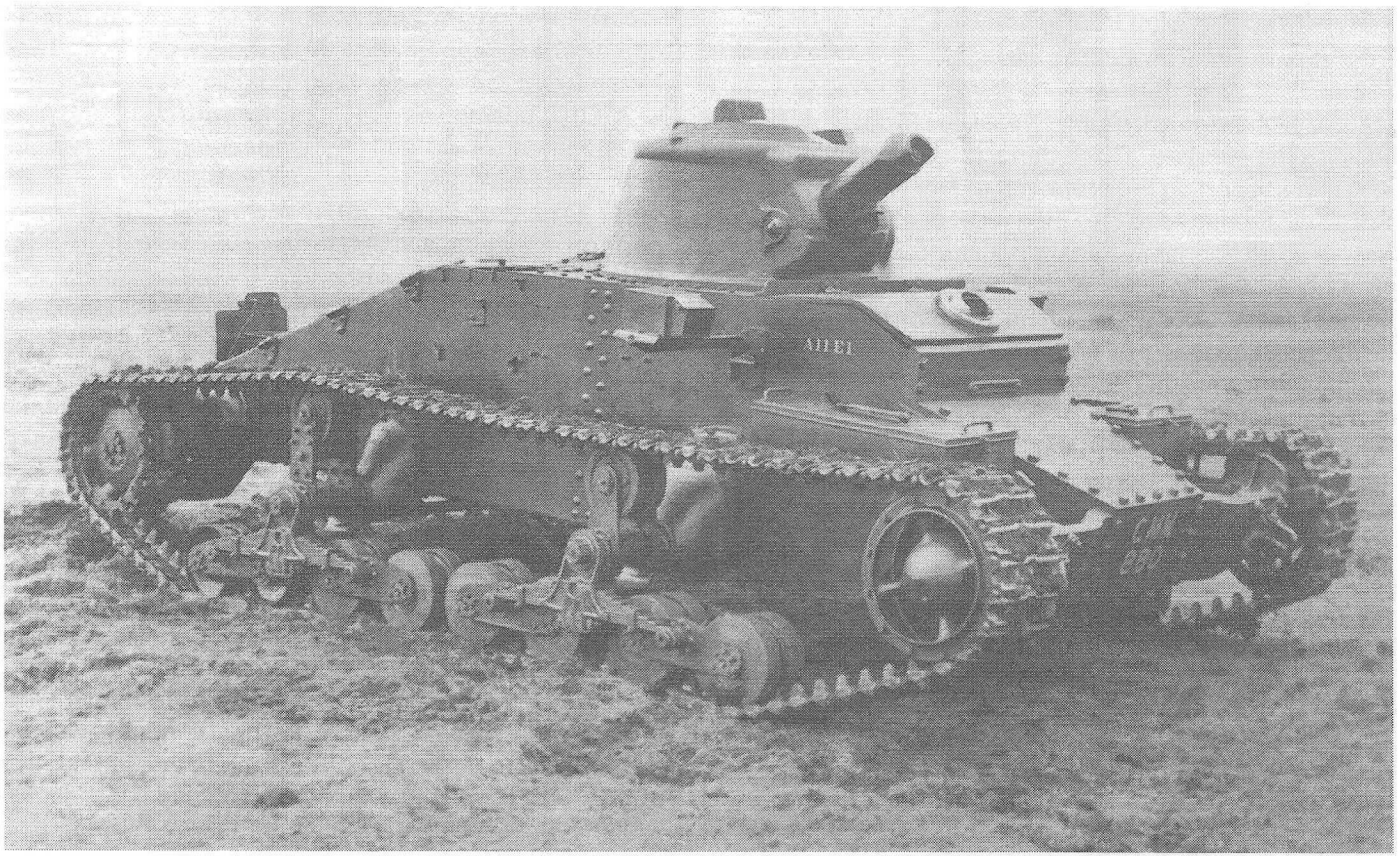
deduct the provision for war reserves in the light of the expansion of productive capacity.

Sir Richard Hopkins, the Treasury official who was chairing the meeting, concluded the meeting by proposing that a report on the proposals within Memorandum No. 57 be submitted to the Chancellor of the Exchequer, Neville Chamberlain. Regarding the Christie tanks, on 13th November 'Q' Martel wrote to Lieutenant-Colonel Joseph Hollebone of the Mechanization Board, to inform him that the first example that had been purchased from America was due to arrive at the MEE at Farnborough in four days' time. This turretless vehicle would be given the development designation of A13E1, with Martel adding that "As Matilda is away there will be no special difficulty over secrecy." In fact, A11E1 had been returned from Chertsey on 22nd October, having had its steering assembly repaired, although it had on several occasions been temporarily sent back to Vickers-Armstrongs for further reworking. This statement also indicated that Hugh Elles' wish that manufacturers should study each others' designs was not being recognised, as A11E1 was plainly being kept out of the purview of Lord Nuffield's engineers. Nuffield himself would be an innocent bystander to a notable example of intrigue when he visited the Royal Tank Corps' headquarters at Bovington Camp in Dorset on 20th November, in company with Winston Churchill and Basil Liddell-Hart, a journalist who was considered one of the primary military theorists of his day. Liddell-Hart was a particularly ardent advocate of the transformative role of the tank, a position that made him a close ally of the luminaries of the Royal Tank Corps, and none more so than Percy Hobart. Liddell-Hart would compose a brief account of the event on 23rd November for an unidentified recipient, the most likely candidate being the Chancellor of the Exchequer, Neville Chamberlain, who was one of his many powerful admirers. This began by relating that:

> On Friday I went to the Tank Corps Dinner, my fellow guests being Winston and Nuffield — who seems to be really throwing himself with enthusiasm into the production of tanks. He will need it, for I was surprised at the severity with which everyone to whom I talked criticised Hugh Elles, the Master General of the Ordnance (who was also present as one of the Colonels Commandant of the Corps). They all complained of the feebleness and inefficiency which he has shown during his regime. He used to be generally popular because of his pleasant manner, although I have heard a number of his contemporaries describe him as a 'flat-catcher', but it is now clear that he has completely lost the confidence of most of his subordinates.

A "flat-catcher" was a colloquial term for a racehorse whose appearance flattered to deceive. That Hobart and his clique were so dismissive of Elles was unsurprising, as they had been envisaging the development of an ambitious concept for a Medium tank that could operate virtually independently of all other arms, thus ensuring that the Tank Brigade could perform as a battle winning formation almost on its own. Instead, Elles' concept of the Infantry tank would tie the RTC to a narrowly defined role that would be dependent on intimate collaboration with the infantry and artillery, this prompting such unease that "there are fears that the Tank Brigade is to be broken up, and that the Mobile Division is not being formed — although the Cabinet were recently assured that this was well in progress." However, Elles had been far from the only senior officer to be subjected to severe criticism, as Liddell-Hart recounted that "Apart from the M.G.O.'s inefficiency, which is held to be largely responsible for the failure of tank supply that recently aroused the Cabinet's anxiety, the obstinate conservatism of the Adjutant-General, Knox, is regarded as a general stumbling block in the way of all progress." As the Adjutant-General to the Forces, General Sir Harry Knox was in charge of the Army's personnel policies, and was also, along with the Master-General of the Ordnance, a member of the Army Council, which was the supreme administering body of the British Army. Liddell-Hart was also sceptical of this particular organisation, as "Nobody seems to have much hope of the present Army Council, as apart from these two the Q.M.G., May is merely an administrator, while the C.I.G.S., Deverell, although the best of the bunch, is felt to be too cautious and limited in the scope of his ideas to push along such a team." The Quarter-Master General (QMG), General Sir Reginald May, along with the CIGS, Cyril Deverell, completed the quartet of "military" members of the Army Council, the three "civilian" members being the Secretary of State for War (Duff Cooper), the Parliamentary Under-Secretary of State for War (Donald Sterling, Lord Strathcona), and the Financial Secretary to the War Office (Sir Victor Warrender). As such, Liddell-Hart had depicted the entire senior military leadership of the Army as being out of touch with their subordinates and consequently ripe for removal.

During November E.M.C. Clarke had considered fitting the air cooled Czech ZB 53 7.92 mm machine gun (later the Besa) into A11E1 as a potential substitute for the 0.303-in. Vickers machine gun, thereby obviating the need to install a cooling system. However, this weapon was gas operated, with its gas cylinder being located on the underside of the barrel, and as the barrel would need to project outside the turret, the cylinder was rendered vulnerable to the intense small arms fire that an Infantry tank was likely to face. Clarke doubted the possibility of adequately protecting



A11E1 fitted with a proper visor plate and driver's periscope, stowage bins, number plates, and fabricated headlamps. The idler wheels have been modified to incorporate plain rims, while the two rear bogie wheels are of the steel-rimmed type. A mock-up commander's cupola has also been fitted on the roof, replete with fake periscope. (National Archives)

the gas cylinder while also rendering the gun mounting proof against bullet splash (*i.e.* the finely divided or liquefied metal resulting from bullet impacts) and so this project was quickly dropped. In the event, an adequate shield for protecting the ZB 53 barrel was adopted for subsequent tank designs, although the most pertinent limitation of the gun, which was its ejection of noxious carbon monoxide fumes on firing, would have precluded its use in the confined space of the A11. It was therefore decided to retain the 0.303-in. Vickers machine gun, with a modified version of the standard cast iron No. 8 mounting, although as splash proofing would be critical for the Infantry tank, he had suggested that the efficacy of the mounting against splash be tested as early as possible. As Vickers-Armstrongs anticipated that rifle calibre ammunition would not cause serious damage, Clarke arranged for a trial to be undertaken on the 30 yard range at Farnborough on 9th December, with the mounting being subjected to 0.303-in. (7.7 mm) rifle and machine gun fire, using standard ball ammunition. This evaluation was conducted by the 2nd Battalion of the Royal Tank Corps, although only rifle fire was employed as the Vickers representative in attendance suggested that machine gun fire might cause the mounting to fracture. However the rifle fire on its own was sufficient to break off parts of the mantlet (the external portion of the mounting), with Clarke deeming the result to be inconclusive. This did not prevent 'Q' Martel placing an order for production mountings, albeit to a revised design that was to be submitted by Vickers.

On 11th December MGO5 notified the MEE that A11E1 should be placed at the disposal of Captain J.L. Winberg of the AFV Gunnery School, Lulworth, for a "user opinion" evaluation, which would also include stowage trials. This evaluation was undertaken by Percy Hobart and 'Q' Martel, as well as Lieutenant-Colonel Herbert Paterson of the Royal Tank Corps' inspectorate (IRTC), Lieutenant-Colonel Terence Murray of the RTC, and Captains J.S. Fernie and F. Cronin of the 4th Battalion of the RTC. Also present was Captain John Runciman of the Gunnery School, the group's subsequent report, which was forwarded to Vickers on 19th December, containing only minor criticisms regarding crew comfort and vision. MEE report A45/1 was issued on 22nd December on the latest status of A11E1, which had by this time accrued 755 miles (1215 km), of which 583 (939 km) had been across country and 172 (277 km) had been on the road. On its initial return from Chertsey, the repairs to the steering assembly on the nearside had included new planetary gears, new springs for the steering clutch, new shoes (also called "bands") for

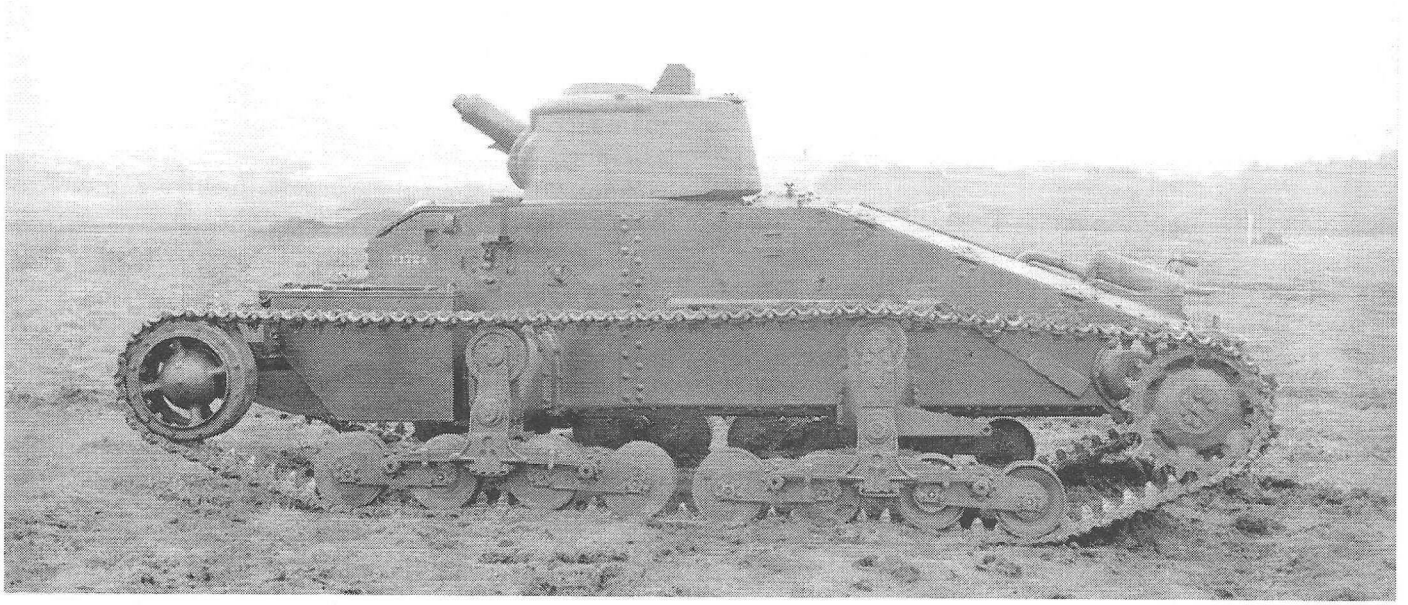
the steering brake, and a new final drive pinion shaft and ball race for this shaft. On the offside, only the ball race for the final drive pinion shaft had been replaced. It was also recorded that the footbrake had been removed, while the governing had been reset at 8 mph (13 km/h), as expected. A number of other modifications had been implemented by Vickers-Armstrongs, as they had stowed A11E1 with its full equipment, and fitted stronger springs to the rear suspension units. In line with the recommendation made by the MEE's initial report A45, a positive locking device had been fitted to the idler wheels, although its precise form was not described, the new report A45/1 commenting that "The positive stop for the track adjustment, which has now been fitted, is satisfactory." There had also been an attempt to address the issue with the dipstick needing to be bent on withdrawal, as:

> The makers have now fitted a flexible dipstick for the engine oil level. This is not satisfactory as the spring wire gets kinked. The pipes to the oil cooler should be repositioned to allow better accessibility at this point.

A number of alterations had also been made by the MEE themselves, including a mock-up commander's cupola on the turret, and a mock-up No. 11 Wireless Set installation, this being a short-range set for co-operation between the tanks within a troop. The original mock-up wooden front plate of the driver's hood had been replaced by an armoured plate designed by the Design Department at Woolwich. A periscope had also been installed in the driver's escape hatch, this device also being a Woolwich design, it being relayed that "This is satisfactory except that it has been found that, after driving through it for about half an hour, the eyes tend to exaggerate the size of obstacles." The periscope was not the only means of observation when "closed down", as an improved front slit had been provided, this being wider and having an internal Triplex glass visor to protect from bullet splash. The slit was deemed to be "adequate for slow speeds, but leave[s] 9 ft. [2.7 m] of dead ground in front of the machine." The driver's hatch was opened and closed by means of a pair of hand-pumped hydraulic supports, with report A45/1 opining that "The top flap over the driver might with advantage be attached to the vertical supports by quick release pins, in order to allow the driver to make a more rapid exit in an emergency." These pins would effectively detach the hatch from the supports, so that the driver could manually push it open and evacuate accordingly. It was also advocated that "The driver's seat back should fold towards the rear and not towards the front, as at present." This would allow him to more easily evacuate via the turret, should that be necessary, for example when his hatch was jammed or obstructed by the position of the main armament. A guard had also been placed over the driver's starter motor switch, in order to prevent it being accidentally actuated. One more recommendation would be offered regarding the driver's vision, this being that:

> It has been suggested that two driving mirrors near the centre of the front glacis plate are provided

As well as being bearing the vehicle registration mark CMM 880, A11E1 was also given WD number T1724, as stencilled on the offside of the driver's compartment. From this view it can be seen that the sprockets have been raised by means of lowering the rear suspension bogies, the rear return rollers being retained in the same position by extension plates projecting upwards from the rear suspension axles. *(National Archives)*



in order that the driver can, even when closed down, see any over-taking vehicle, etc. This will be tried out at a later date.

As we have seen, A11E1 had only been temporarily fitted with a single driver's mirror on the offside, and so at the present time, could only see an overtaking vehicle approaching on that particular side, which was suitable for British, but not Continental, roads. It was of course the case that the tank's low speed would result in it being subjected to constant overtaking. New idler wheel axles had been fitted after 610 miles (980 km) to replace the pair that had become bent, the opportunity being taken to change the original toothed idler wheel rims for smooth ones, with the report disclosing that:

Since fitting a plain, in lieu of the toothed, idler wheel, the vertical climbing capacity has been reduced. The vehicle will now climb 2′ 1″ [65 cm] easily, but will not climb 2′ 7″ [80 cm] as before.

As anticipated in the previous report A45, further trench crossing tests had been conducted, these finding that A11E1 could cross a 7 ft. (2.1 m) trench easily, although it eventually failed to negotiate a gap of 7 ft. 6 in. (2.3 m). A complementary series of runs in reverse gear had been enacted, these revealing that a 6 ft. (1.8 m) trench could be traversed without difficulty. Fording trials had also been undertaken, the report communicating that:

At 2′ 6″ [75 cm] depth, water enters the engine compartment through holes in [the] belly plate and is circulated by the fan belt. If these holes were closed, [the] machine could ford up to about 3′ [90 cm] for short distances.

As the belly plate was only 15 in. (38 cm) above the ground, it can be assumed that water had commenced entering the vehicle before the full 2 ft. 6 in. (75 cm) depth had been reached. Additional cooling trials had been run at low speed, with 2½ mph (4 km/h) being maintained in top (*i.e.* 4th gear), this producing a maximum water TD of 125 °F (52 °C). The TD of the lubricating oil was also 125 °F (52 °C) in the engine sump, this being reduced to 105 °F (41 °C) by the oil cooler. When running at the same speed in 3rd gear it was found that the cooling water TD dropped to 113 °F (45 °C), although the TD of the oil remained the same. It was assessed that the range of A11E1 was 90 miles (145 km) on road and 80 (130 km) miles across country, this being broadly in line with expectations, it being mentioned that 21½ gallons (98 litres) of petrol in each of the two tanks could be usefully employed, these tanks having an official capacity of 21 gallons (95 litres).

New tracks had been fitted by Vickers-Armstrongs at Chertsey on 8th December, the firm taking the opportunity to straighten out the new idler wheel axles, which had splayed out as per the original examples, and check the entire track assembly for alignment. Following that date A11E1 would run another 76 miles (122 km), of which 41 (66 km) had been on road and 35 (56 km) across country, it being recorded that "28 track pins have broken during this period, showing that the trouble was not due to the misalignment of the tracks." Accordingly, on 15th December the inner set of track guide segments were removed from the nearside sprocket and both sets of segments were taken off the offside sprocket, it being recounted that:

During running on this day (20 miles [32 km], all C.C.) severe swinging on gravel was carried out. One pin broke on the offside and 10 pins on the nearside; (these breakages are included in the total given above). One track plate (off-side) was twisted. This experiment is being continued, as it is thought that the absence of segments may improve the life of the pins. The chief cause of the trouble is apparently due to the nearness of the ground to the sprocket. This allows an accumulation of stones, etc., to get between the track and the sprocket and stretches the track to an undue extent.

"Swinging" was the steering of the tank by the full application of one of the skid brakes, thus causing the machine to veer abruptly in the direction desired. In order to raise the sprocket further from the ground, two courses of action had been proposed, the first being to raise the entire hull by three to four inches (8–10 cm) by lowering the mounting brackets for the suspension bogies, and the second being to rotate the final drive casings rearwards and upwards in order to raise the sprocket hubs by two to three inches (5–8 cm). The report submitted that "It is also suggested that in future, pins for this type of track are manufactured with a 'lead in' at their ends to facilitate assembly." This "lead in" would basically be a fillet or chamfer on the ends of the pins so that they slotted into the track link lugs without interference. Apart from the track pins, the only other defect encountered during this second period of running was the speedometer drive breaking at 640 miles (1030 km), this being repaired at Chertsey. It was now intended to run A11E1 up to 1000 miles (1600 km), of which 800 (1300 km) were to be cross country and 200 (300 km) on road, after which the performance trials were to be repeated. On 31st December, Noel Hudson issued Mechanization Board Minute A2842 to Alexander Davidson, giving an overview of the trials of A11E1 at the MEE. This declared that "Considered as a first production

model the performance and reliability of this vehicle during a total of 750 miles [1200 km] running at Farnborough have been promising." Hudson generally reprised the contents of MEE reports A45 and A45/1, although he did note that the accessibility issues that had been identified in the first of these reports were being addressed at Chertsey, as:

> Accessibility for maintenance is satisfactory with the exception of the items enumerated below:-
>
> (a) The distributors, situated between the engine and radiator, below the fan. A scheme for repositioning these components is under consideration.
>
> (b) The dip stick which indicates the engine oil level has to be bent before it can be removed. A modified spring type of dip stick will be incorporated in future vehicles.
>
> (c) A small hinged door will be provided on future vehicles, to facilitate access to the carburettor.
>
> (d) The brake covers will be readily detachable by means of quick release fasteners and a door will be provided in the rear top plate to give access for the adjustment of the brakes and steering clutches."

In the latter instance, this meant that the two relatively small doors currently employed would be replaced by a single larger one. The 'A' Committee of the Mechanization Board had also decided that of the two possible methods for raising the drive sprockets, that of rotating the final drive casings rearwards was to be adopted, with Hudson remarking that "The position of the top rollers will require alteration to suit." The "top rollers" in this instance were the return rollers at the top of the suspension bogies. The verdict that the rate of turret traverse was too slow had prompted Vickers to adopt an alternative design with a faster gear ratio, with Hudson urging its installation on A11E1 for assessment as soon as it was available. A dust excluder, which was not fitted in A11E1, was also to be incorporated in the final design of turret, while the issue of the fuse box fouling the driver's left knee was also being addressed by the firm. The samples of lubricant from the engine had also been examined, as:

> Before the trials were commenced the Board were in close touch with the Ford Motor Co., Ltd., and it was decided to change the lubricant on a basis of revolutions performed by the engine corresponding with those in a Ford 2-ton van. Samples of lubricant were forwarded to the Ford Motor Co., Ltd., and the results were so satisfactory that it has now been found possible to double the periods for changing the oil.

The Ford V8 would be subjected to particularly heavy duty on the A11E1, as when governed to 8 mph (13 km/h) it was rated at around 2800 rpm, and so a more viscous lubricant would have been necessary for this application, in comparison to that of a commercial van, although the specified Castrol XL was nonetheless a commercial oil. On 1st February 1937 Lieutenant-Colonel George MacLeod Ross, who had replaced E.M.C. Clarke as the head of the 'M' section of the Design Department at Woolwich, minuted Alexander Davidson on his proposals for a new machine gun mounting for the A11. It's basic design was similar to the modified No. 8 mounting that Vickers-Armstrongs were working on, although Ross's proposal included a number of minor alterations, including a change in the mantlet material to 100 ton cast steel (*i.e.* steel with a tensile strength of 100 tons per square inch, or 1545 MPa). The increased hardness and brittleness of this material would result in it being chipped rather than burred when hit by armour piercing (AP) bullets, thus reducing the possibility of the mantlet being jammed in position by bullet impacts. However the choice of production material would continue to reside with Vickers. Elsewhere, MGO5 had raised the possibility with the firm of the A11 mounting a heavier calibre 0.5-in. (12.7 mm) Vickers Machine Gun, with the caveat that "if it is going to cause any appreciable delay or involve considerable alterations to work already done, we will not insist on this".

MEE report A45/2 was compiled on 2nd February 1937 after A11E1 had completed 1020 miles (1640 km), of which 814 (1310 km) had been across country and 206 (330 km) on road. This was prompted by an apparent failure of the nearside planetary reduction gear, an examination of the dismantled assembly revealing the collapse of the double ball bearing that supported the inner end of the shaft for the driving gear (or "sun gear"). This pinion was the output from the steering clutch assembly, the report purporting that "There was no reliable evidence to show how the failure of the bearing had occurred, except that some of the tabs on the tab-washer under the bearing retaining nut were turned slightly inwards towards the bearing and may possibly may have come into contact with the balls." The bearing was nevertheless replaced with a new one, it being found that the corresponding bearing in the offside planetary reduction assembly was in perfectly good condition. The opportunity was also taken to assess the condition of the pinions themselves, as well as the bevel gear outputs from the gearbox, the report acknowledging that "The teeth of all these gears were found to be slightly bruised." It was however considered that "their condition does not justify any replacement at present." MEE report A45/3 of 25th February 1937 dealt with the elevation of the drive sprockets, remarking that "Owing to the continual breakage of

track pins on this machine (147 have been broken in 1150 miles [1850 km]), authority was obtained to raise the height of the sprocket and to carry out mileage tests." Rather than rotating the final drive casings rearwards as was the intended production solution, the more simple modification was undertaken of repositioning the brackets for the rear suspension bogies lower down on the hull, this effectively raising the sprockets by approximately eight inches (20 cm). An initial run of nine miles (14 km) was conducted with all the guide segments removed from the sprockets, it being avowed that "Both tracks over-rode the sprocket teeth during swinging tests and 6 track pins broke." The outer segments were consequently refitted, and a further 120 miles (190 km) were run, of which 113 (182 km) were across country and seven (11 km) on the road, the evaluation being interrupted by what was described as "a serious engine failure". It was nonetheless observed that "No pins broke during this mileage, although the machine was swung more than normally", this prompting the comment that:

> Although the mileage has not been sufficient for any definitely conclusive results to be obtained, it is significant that at no time previously during the life of this machine have 100 miles [160 km] been covered without a track pin breakage, even directly after new tracks have been fitted.

The report therefore drew the conclusion that:

The improvement gained through raising the sprocket height is thought to be due to the following reasons:-

1. The greater immunity from stones, which normally tend to pile up during swinging and to wedge between the track and the sprocket.
2. The fact that the rear bogie wheel, owing to the greater angularity of the track between it and the sprocket, can be pulled up against its spring when the track is stretched and thus, to some extent, relieve the tension on the track.

This view of A11E1 gives a better appreciation of how the rear suspension mountings have been lowered in order to experimentally raise the drive sprockets. A Tangye screw jack is carried on the rear plate in order to lift the vehicle while the rear suspension bogies are being raised or lowered, a shoe bracket being mounted on each of the rear suspension axles in order to secure the jack in position when it is being employed. Note the original central position of the exhaust silencer, it having discrete transmission compartment access doors on either side of it. (National Archives)

There was in fact a third possibility that had not been considered, this being that the tracks would have been far less likely to have borne the weight of the tank directly through the sprocket when surmounting minor obstacles, as the sprocket would now only be in direct contact with the ground when climbing the very steepest impediments. Despite this apparent success, report A45/3 stated that the rear suspension bogie brackets were being returned to their original positions, while all the suspension bogies had been sent back to Chertsey to have their return rollers sprung, this also providing more "play" for the tracks. It was also affirmed that new sprocket rings and tracks were to be fitted, these being the third set of tracks to be made available for the machine, the second pair having been fitted by Vickers on 8th December. The failure of the Ford engine had elicited yet another MEE report, this being A45/4, of 3rd March 1937, which confirmed that the engine had failed after 1150 miles (1850 km), of which 935 (1505 km) had been across country and 215 (345 km) on road, the first sign of something being amiss being the presence of water in the sump. A subsequent stripping of the engine had uncovered that the gudgeon pins for the pistons had sheared in the No. 1 (*i.e.* frontmost) cylinder on the right hand bank and the No. 2 (*i.e.* second from front) cylinder on the left hand bank. The tubular gudgeon pin joined the piston to its connecting rod, which was itself attached to the crankshaft, and in both cases the pins had broken at their centre groove, where a plain bearing (or "bush") was located to interface with the "small end" of the connecting rod. The consequent damage in the No. 1 cylinder piston had been catastrophic, with the piston having completely disintegrated and the small end of the connecting rod having fractured. One end of the gudgeon pin had worked free from the piston and torn the cylinder lining, this causing an ingress of water from the cooling water jacket, which inevitably drained down to the sump. The damage in the No. 2 cylinder was less severe, although the piston skirt (*i.e.* the vertical portion of the piston below the rings) was discovered to be fractured, and the cylinder lining had been scored by the free end of the gudgeon pin. It was imparted that "Several of the remaining piston skirts were slightly fractured, probably by contact with fragments from either of the above more seriously damaged pistons." The report further detailed that:

> Evidence shows that the initial cause of the failure is the shearing of the gudgeon pins, No. 1 cylinder showing a more advanced stage of the same type of damage as No. 2. The depth of the grooves in these gudgeon pins is such that the cross section of the pins is extremely small at this point.

A new engine was provided by the Central Ordnance Depot at Chilwell in Nottingham, and arrangements were made for the original engine to be examined by an engineer from Fords. This was duly documented by an addendum to the report dated 15th March, which confirmed that "Examination of the above engine by the maker's representative has now taken place, and he agreed that the probable initial cause of the failure was the shearing of the gudgeon pins." It was then related that "He remarked that this failure had not been entirely unknown to them in the past, and further stated that gudgeon pins are now being made of stouter cross section at the groove where the shearing occurred." War Office Memorandum No. 95 was issued on 19th March, forewarning of a number of potential amendments to Memorandum No. 57, including the notification that a new design of Infantry tank was under consideration. This was of course the tank that had been tasked to the Vulcan Foundry, which would be designated as the A12, and despite the original preference for a single engine would now be powered by a pair of AEC diesel engines driving a single epicyclic gearbox. The memorandum advised that "The new type may carry three men, so that the addition of 15 medium tanks to an army tank battalion may not apply, and the battalion may be composed of 75 'I' tanks of the new type eventually." The potential removal of the Medium tanks had been enabled by the likelihood that a proportion of the newer Infantry tanks would be fitted with 2 pounder anti-tank guns, and therefore capable of providing an anti-tank defence, it being submitted that "The cost of this type of 'I' tank cannot yet be assessed, but it may be in the region of £16,000 including armament." Such a change would reduce the number of Medium tanks needed from 400 to 247, with the Infantry tank requirement correspondingly being raised from 680 to 833, of which 285 would be held in reserve for war wastage. The overall requirement for 350 Cruiser tanks would remain as set out in Memorandum No. 57. It should be recalled that the estimated cost per unit for an A11 was £9,000 and for a Medium tank was £13,000, so it was envisaged that this rebalancing would incur a further extra cost of £5.5 million beyond that given in Memorandum No. 57, this bringing the overall total for the tank programme to just over £17¾ million.

On 22nd March Alexander Davidson chaired a meeting at the War Office to discuss the armour plate specifications for the production A11, this also being attended by 'Q' Martel and Leslie Little of Vickers-Armstrongs. Davidson explained that a firing trial had been conducted at the Royal Artillery's gunnery school at Shoeburyness in Essex on 16th March, this indicating that 60 mm thick rolled or cast plate was proof against the 2 pounder gun at its maximum striking velocity (*i.e.* at point blank range). However, Davidson was

worried that this thickness still "had not sufficient margin or resistance to allow for variation of the conditions". This comment tended to indicate that the trial had been conducted at the standard oblique test angle of 30°, and so could not guarantee immunity if the plate was hit from normal. It should be noted that at this time the standard 2 pounder round was of the APHE type, this being a shell that incorporated a burster charge designed to detonate after penetration. The price of including the burster was that the solid metal content of the round was reduced, thus lowering its penetrative capacity, and there were plans afoot to produce a solid shot round that would be substantially more effective in this regard. In order to provide better immunity for the A11, Davidson proffered two potential courses of action, these being to increase the plate thickness or to increase its tensile strength. In response, Leslie Little argued that increasing the tensile strength beyond 70 tons per square inch (tsi; 1100 MPa) would make the plate virtually unmachinable, while increasing the plate thickness would result in substantial redesign. He did, however, state that the plate thickness on the A11 could be increased to 70 mm as Vickers had made allowance for this possibility in their design. The meeting decided to only change the specification of the turret however, whose thickness would be increased to 65 mm, the steel chosen being Vibrac 45 with a tensile strength of 70 tsi (1100 MPa). This was an unusual choice of material, it being a Vickers proprietary general engineering alloy steel, and in the event War Office specifications would be employed for both the rolled plate and cast armour used on the A11, these being IT 80B and IT 90B respectively.

Davidson held a subsequent meeting the next day, 23rd March, with Rear-Admiral Julian Patterson of the English Steel Corporation, this being a Vickers subsidiary that produced the firm's armour plate. Patterson reinforced Leslie Little's comments on utilising plate with a tensile strength of 70 tsi (1100 MPa), stating that steel of this specification was difficult to work (*i.e.* to form) and that problems might be experienced in providing sufficient flatness. He also suggested making allowance for "the possibility of meeting heavier shell in the future against which steels of the higher tensile qualities were unsuitable". This was because steel with a lower tensile strength would be more ductile, and therefore better able to absorb the blast effect of heavy shells. For the thinner rolled plates, 'Q' Martel explained that these would have to withstand 0.303-in. rifle bullets, and so would have to be of 14 mm "homogenous hard" tank armour (*i.e.* IT 70), while he reiterated that all plates above that thickness would have to be proof against the 2 pounder. On the subject of cast plates, Patterson repeated that "high tensile was not entirely a blessing", as any subsequent heat treatment applied for surface hardening would be more prone to induce defects. It was nonetheless agreed that a cast turret of high tensile steel should be provided for firing trials. On 2nd April MEE report A45/6 was issued on the general progress of A11E1, this by now having accrued 1481 miles (2384 km), of which 1209 (1946 km) had been across country and 272 (438 km) on road. Although report A45/3 had stated that the mounting brackets for the rear suspension bogies had been refitted in their original position, on receipt of the replacement Ford engine they had been lowered once again, albeit to a lesser degree such that the rear sprockets were five inches (13 cm) higher rather than the previous eight inches (20 cm). Over the first 209 miles (336 km) of running at this revised setting, nine track pins and one track link were broken, while a large number of other links and pins had been bent. By this time the tracks themselves, which were the second pair to have been fitted to A11E1, had accumulated 657 miles (1057 km), and it was decided to fit a new set. This third pair of tracks, which had originally been intended to be fitted at 1150 miles (1850 km), had in fact been fitted at 1359 miles (2188 km), and had accrued 122 miles (196 km) without any track pin or track link breakages, this including the performance of two "figures-of-eight" on sand and gravel during each two mile (3 km) circuit of the Long Valley in Aldershot. The new sprocket rings had not been fitted however, as the urgency of the trials had not given time for their fixing holes to be drilled, the report additionally disclosing that:

> The 'S' shaped securing wires for the track pins, especially those on the third pair of tracks, are extremely hard to break when it is required to remove a link, etc. They are apparently inserted hot and cannot be cut with an ordinary chisel. The attention of the makers should be directed to this point.

These securing wires would have performed the same function as a circlip, by preventing the track pins from sliding out of the lugs of the track links. Regarding the idler wheels it was mentioned that "The new front idler wheel spindles, which were fitted at 610 miles [980 km], have bent and are being replaced with a new type of stronger design by the makers." This would appear to be the second time that these items had deformed, having previously been straightened by Vickers. The plain idler wheel rims that had also been affixed at 610 miles (980 km) had since become damaged, although they were still deemed to be serviceable. The most likely cause of damage was unsurprisingly thought to be stones becoming wedged between the wheel rims and the tracks. The rubber tyres of the road wheels had also sustained damage, this being due to the track guides wedging between the inner sides of the tyres and their steel mounting

rims. After 924 miles (1488 km) five of the road wheels on the offside were replaced due to this trouble, these being from the No. 3 (*i.e.* third from front) to No. 7 stations. At 1380 miles (2222 km) this defect was found to have occurred at the No. 5 and No. 6 stations on the nearside, although the report commented that "the wheels are still considered to be serviceable and are being kept under observation." The MEE had made and fitted a pair of mudguards to cover the drive sprockets, these having proven satisfactory, the report mentioning that "No guards are necessary for the front." On the subject of the transmission, split "Perfect" oil seals had been fitted to the covers of the planetary reduction gears, these being produced by Super Oil Seals and Gaskets Ltd. of Birmingham. However it was experienced that the leaks were "as bad as with the previous seals", the report averring that "It is understood that the makers [*i.e.* Vickers] intend to modify the primary reduction gear casing with a view to obviating the necessity for split covers." It had also been observed that the noise generated by the final drive gears "which has always been excessive, appears to have got worse within the last 250 miles [400 km], presumably due to wear on the teeth." A number of defects had occurred with the transmission, with the speedometer drive failing again as the key that secured its flexible drive cable had sheared at 1235 miles (1988 km).

Shortly afterwards, at 1289 miles (2075 km), the 3rd gear started to slip out of mesh, this defect growing worse to the point that the gear was avoided over the last 50 miles (80 km) of running. At 1359 miles (2188 km) the change speed lever (*i.e.* the driver's gear change lever) broke, the point of fracture being a drilling in its ball joint, this being the lever's pivot point at the top of the change speed box. The lever was repaired, presumably by welding, and refitted. Finally, at 1481 miles (2384 km) the ball race for the offside steering clutch withdrawal cam failed, this prompting the cessation of running, with the gearbox and the offside steering assembly being removed for overhaul, presumably at Chertsey. There were a few minor issues pertaining to the engine, with the saga of the dipstick continuing, the report conveying that:

> A spring steel dipstick for engine oil level is being made for experiment. The standard Ford and the special coiled spring dipsticks supplied by Messrs. Vickers-Armstrongs, Ltd., are both unsatisfactory in use.

The oil filler for the engine was still deemed to be unsatisfactory, as "This is too small to allow rapid replenishment of oil." A dynamo was mounted on the engine to power A11E1's electrical system, it being alleged that its adjustment was difficult as there was "no means of raising the dynamo against the tension of the belts." This suggested that a slotted bracket had not been provided to allow the dynamo to be moved further outboard in order to take up any slackness in its drive belts as they stretched through wear. While A11E1 was "off the road", the new stronger idler wheel axles were being fitted, while "expanded metal" (*i.e.* metallic mesh) guards were being installed over the ventilating air inlets for the engine compartment, presumably to keep out leaves and other large items of debris. Following this, it was intended to complete another 300 miles (480 km) of cross country running with the drive sprockets being retained in the raised 5 in. (13 cm) position, and conduct a repetition of the cooling trials. The transmission defects mentioned in MEE report A45/6 had in fact been covered in more detail by report A45/5 of 25th March. Concerning the tendency to slip out of 3rd gear, a stripping of the gearbox had revealed excessive wear on the leading edges of the teeth of the 3rd speed pinions on both the mainshaft and the layshaft. The teeth of the two 2nd speed pinions displayed similar wear, albeit to a much lesser degree. The report insisted that "It will be necessary to replace the layshaft (all gears integral on this shaft), and the 3rd speed gear on the mainshaft", and that "The spigot end of the mainshaft shows quite appreciable wear, but the shaft is still serviceable." The spigot end of the mainshaft was the front end, which interfaced with the drive shaft from the engine clutch, the spigot being mated into the drive shaft by means of a Hyatt roller bearing. The rear end of the mainshaft was splined to a flanged coupling, which was in turn bolted to the bevel gear output for the steering clutches and final drives. For both the layshaft and mainshaft, the condition of the bearings was assessed as being "fair." For the offside steering clutch assembly, it was found that the ball race of the clutch withdrawal cam had completely disintegrated, the cam itself becoming detached from the presser plate of the steering clutch and seizing on its distance piece on the cross-shaft. Report A45/5 demurred that "It is difficult to deduce the sequence of events from the evidence available, but it is considered that the disintegration of the race is the most likely first cause."

On the recommencement of running the repaired gearbox did not last long before more problems emerged, with MEE report A45/7 of 8th April noting the emergence of excessive end-play on the layshaft at the 1565 mile (2520 km) mark. The layshaft assembly consisted of a fixed shaft that was retained by bosses in the gearbox casing. At each end of the shaft was a Hyatt roller bearing, the two bearings being separated by a spacer sleeve. It's four gear pinions were mounted on an outer sleeve, this assembly being known as a "multiple gear" which covered the fixed shaft and rotated on the Hyatt bearings. The report recalled that "It was found that the hub of the 4th speed pinion of the multiple gear had worn into the face of the adjacent

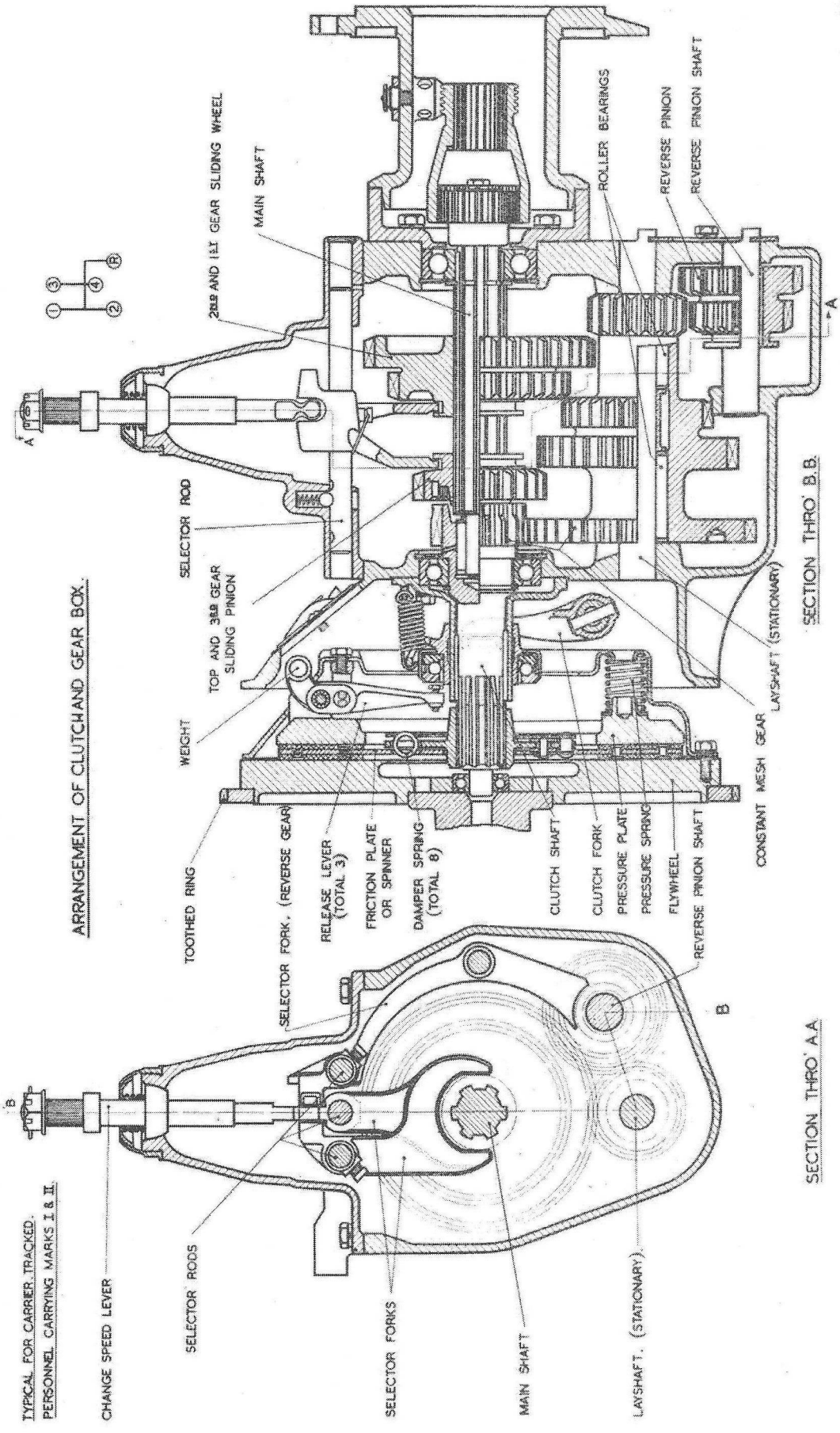


Diagram of a four speed Ford gearbox similar to the one employed in the Infantry Tank Mk. I, although this is the version fitted in the universal carrier. The change speed lever, selector rods and selector forks proved vulnerable to fracture in the A11 due to the stresses induced in engaging at right angles.

boss on the casing, thus causing the excessive end-play noted", and that:

> Further examination showed that the spacer sleeve between the two Hyatt bearings is made from a piece of flat steel plate 3/32" [2.5 mm] thick bent into a rough cylindrical shape. Actually this sleeve was by no means a true cylinder. The roughness of the join causing it to be both tapered and 'stepped' at the ends.

It was consequently suspected that the distorted shape of this sleeve, in combination with slight wear in the Hyatt bearings, had caused the bearing rollers to lie slightly out of parallel with the axis of the layshaft, thereby encouraging the multiple gear assembly to skew towards one end. It was therefore recommended that the current crudely manufactured spacer sleeve be replaced by one that had been "turned", which presumably meant that it be turned and bored from a solid bar. Otherwise it was noted that "A new gearbox has been fitted, and the defective one will be re-conditioned as soon as parts are available." This new gearbox did not last long before it too failed, as after only 47 miles (76 km) the gear selector fork for 3rd and 4th gears sheared at the base of its shank and fell into the bottom of the gearbox. The sliding gears that were actuated by the selector forks were located on the mainshaft, although in this incident the 1st gear pinions on both the mainshaft and layshaft were slightly damaged, with report A45/8 of 12th April explaining that "This damage is not, however, serious and the teeth have been dressed." It was surmised that this failure had occurred just prior to a change down from 3rd to 2nd gear, the broken fork allowing the 3rd gear to remain selected while the selector fork for 1st and 2nd gear attempted to engage the latter. This in turn had caused the engine clutch to violently slip, tearing the linings on both sides of its driven plate, and heating and scoring the linings of the presser and flywheel plates. As a consequence a new engine clutch was fitted to A11E1, with the broken selector fork also being replaced in the gearbox. However, the next general progress update on A11E1, which was MEE report A45/9 of 21st April, would helpfully point out that "It is pointed out that the gear change fork which had sheared, had been on the machine for the full 1612 miles [2594 km], not having been changed with the gearbox at 1565 miles [2518 km]."

Report A45/9 mentioned that the tank had now covered 1791 miles (2884 km), of which 1516 (2441 km) had been across country and 275 (443 km) on road, it also being logged that the third pair of tracks had now accumulated 432 miles (696 km) and that "No pins have broken since this 3rd track has been fitted." Of these 432 miles (696 km), it was stated that the first 176 miles (283 km) had been run with only the inner sprocket guide segments fitted, while for the final 226 miles (364 km) both inner and outer sets of segments were fitted, these figures leaving 30 miles (49 km) unaccounted for. Problems with the roadwheels had re-emerged, as at 1543 miles (2484 km) the tyre on the nearside No. 7 (*i.e.* second from rear) road wheel broke off and jammed the track, this wrenching off the master spring from the rear suspension bogie assembly. The master spring was the longest leaf of the leaf spring, this being the second lowest leaf in the case of A11E1, which incorporated an overhang at each end for resting on the pivots for the two pairs of road wheels. The No. 6 road wheel tyre had also torn, and so both the No. 6 and No. 7 wheels were replaced with new wheels and the master spring was reclamped in its correct position prior to running being resumed, the report opining that "It is considered that, in order to prevent frequent tyre failures, an all-steel wheel, as is fitted in No. 8 position, should also be fitted in No. 7." Shortly afterwards, at 1565 miles (2520 km), the offside No. 4, No. 5 and No. 6 road wheels were discovered to be badly grooved, this once again being due to the track guides sliding between the rims of the tyres. The No. 6 road wheel was accordingly replaced while the other two wheels were placed under observation. The drive sprockets had been inspected at the end of this stage of running, the report recounting that "It was found that, when the sprocket rings had been removed, they had been replaced on the sprocket slightly 'out of step' with each other, causing incorrect meshing between the teeth and the track, and thus tending to cause the track to ride off the teeth." This prompted the following recommendation:

> It is considered essential that future sprocket rings are modified in such a way as to prevent a recurrence of this, possibly by the use of a master bolt. This recommendation applies equally to the sprocket rings of the Dragon, Medium, Mk. IV.

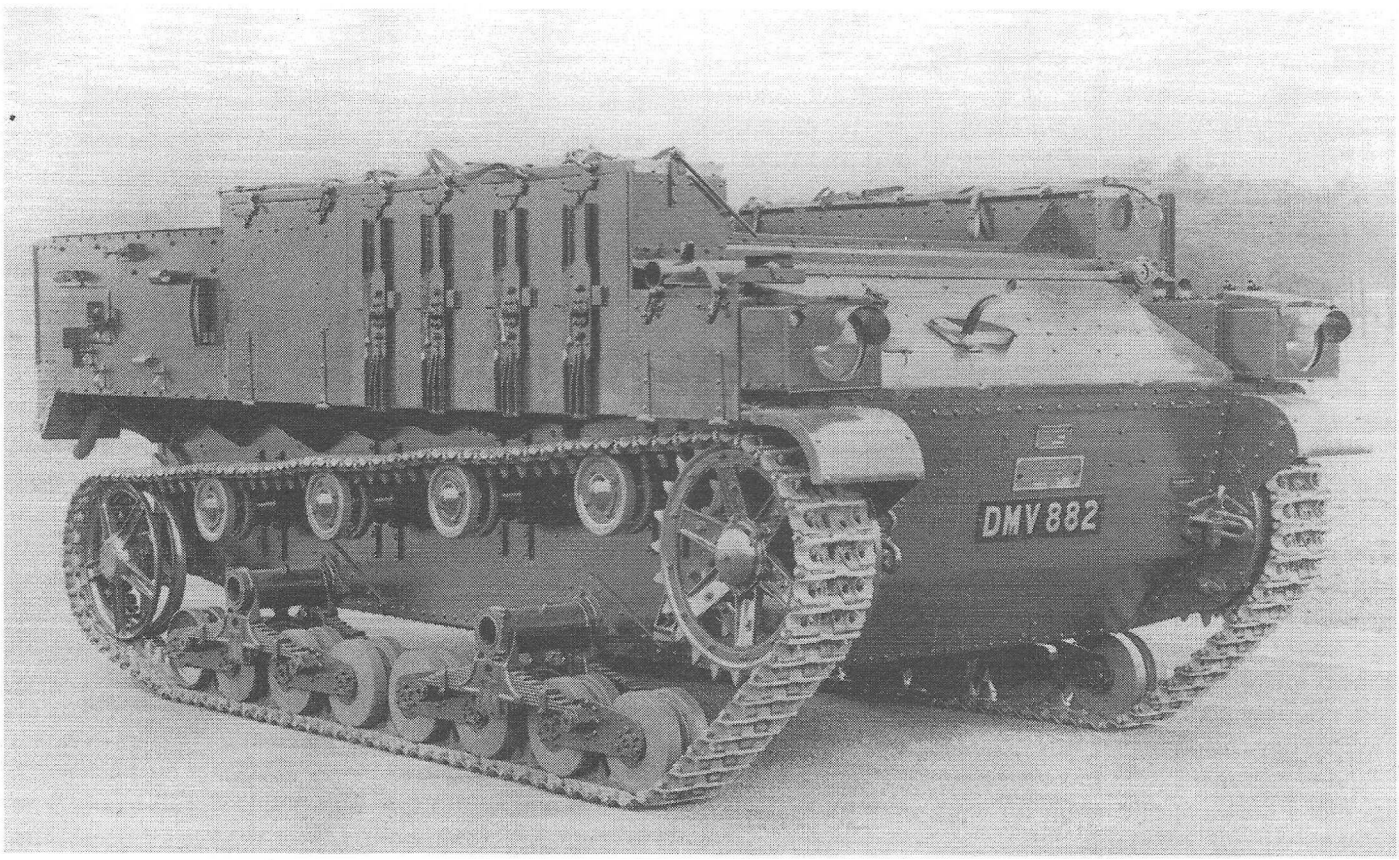
Despite repeated statements of an intention to change the sprocket rings in earlier reports, A45/9 disclosed that "These sprocket rings have not yet been changed, having done the full 1791 miles [2884 km]", and that "They are now considerably worn and will be changed at the earliest opportunity." A lever was provided to engage the track adjustment mechanism on the idler wheel axles, it being pointed out that "This tool, which was modified to fit the new idler wheel brackets, has failed at the welding. A more robust construction is required." These revised brackets, which had not been previously referred to, may have accompanied the fitting of the new design wheel axles. The design had been changed so that the slots in which the tool engaged had been replaced by lugs, such that the end of the tool had been altered to become the "female" component, rather than the "male". The

speedometer drive had failed once again, this time at 1612 miles (2595 km), the report regretting that "The trouble has not yet been investigated." More positively, however, it was also confirmed that "The modified dipstick, made out of 11/32" wide by 1/32" thick [9 mm × 0.8 mm] spring steel, is satisfactory." Repeat cooling trials had been conducted, as presaged in report A45/6, these being undertaken to ascertain the effect, if any, of the expanded metal guards over the engine ventilation inlets. In the event, these were found to have a slight influence on the cooling water temperature, producing a water TD of 118 °F (48 °C) as against the 117 °F (47 °C) measured without them installed. Their effect on the lubrication oil temperature was more substantial, raising the temperature difference before the oil cooler from 135 °F to 140 °F (57 °C to 60 °C), and after the cooler from 120 °F to 126 °F (49 °C to 52 °C). These results had been somewhat ameliorated by the fact that the commander's and driver's hatches had been removed, thereby allowing more ventilating air to pass through the engine compartment via the bulkhead at the rear of the fighting compartment. The hatches themselves had been sent to Vickers at Chertsey to be fitted with the new Vickers Tank Periscope, this in fact being the British-made version of the Polish Gundlach G wz. 34 periscope. Another defect would be encountered with the steering clutches on reaching 1826 miles (2940 km), this time on the nearside with the tank failing to steer to the left. The assembly was therefore stripped, the examination revealing that the clutch presser plate assembly and the individual clutch plates (eleven in total) were floating endways, while wear was apparent on the various components of the clutch withdrawal cam assembly, with MEE report A45/10 of 29th April remarking that:

> This may have been due to lack of lubrication in the thrust race. This clutch withdrawal race has been lubricated with M.600 every 50 miles [80 km], but, owing to the heat at which the steering brakes on this machine run, this lubricant is not retained satisfactorily. Marfak grease is being used in future with a view to overcoming this trouble.

A new distance sleeve between the clutch body and the bevel gear was also installed, while a new cross shaft end nut was provided, the original nut having been subjected to hammering by the loose clutch body. The interruption to running that this investigation incurred was made use of, however, as the replacement sprocket rings were at last put on.

The Dragon Mk. IV artillery tractor that bequeathed its suspension to Matilda. Note that the rearmost bogie wheel is steel rimmed, with testing of the prototype Infantry Tank Mk. I prompting the adjacent wheel to be likewise configured. *(National Archives)*



2. INTRIGUES AND IMPROVEMENTS

Although Hugh Elles and Alexander Davidson were indifferent to the development of an ambitious Medium tank, 'Q' Martel had nonetheless persisted in this endeavour, and after writing various policy papers that had failed to arouse the interest of either his superiors or the senior officers at Woolwich, he had seized on a specification that the Tank Brigade had drawn up for an ideal "1940 Class" Medium tank, this having been included in the appendices of their 1936 training report. This specification was rather extravagant in its personnel requirements, stipulating as it did a crew of at least seven, and preferably eight. The armament was to be to the standard that was now expected of a Medium tank, comprising a 2 pounder (40 mm) gun, a high angle smoke mortar, and three machine guns, of which one would be co-axial to the 2 pounder and the other two in separate turrets. The machine guns were to be arranged so that that all three could fire forwards, two to either side, and one to the rear, this suggesting that the two machine gun turrets would be placed at the front of the hull and be capable of traversing at least 90° outboard. The required road speed for this vehicle would be no less than 40 mph (65 km/h), while its cross country speed was to be 20–25 mph (30–40 km/h), the latter being achieved "without slowing down for minor obstacles and without making [an] impossibly unstable gun platform." Range was to be 200 miles (300 km), this to be facilitated by a diesel engine that produced a power to weight ratio of between 20:1 and 25:1 at an overall vehicle weight of 25 tons. Martel had tasked the head of the 'M' section of the Design Department at Woolwich, George MacLeod Ross, with producing a wooden mock-up of a Medium tank to this specification, although this had failed to impress Alexander Davidson who, according to Martel, had stated that he "did not think it would be wanted." Martel believed that Davidson was reflecting the views of Hugh Elles, and so during February had organised what he termed a "soviet" meeting with Percy Hobart, Brigadier Gordon Macready, who was the Deputy Director of Staff Duties (DDSD), and Lieutenant-Colonel George Surtees of Staff Duties 2 (SD2). Together the four men had tidied up the Tank Brigade's specification to produce what they now called a "Medium Tank 1938 Class". This kept most of the provisions of the previous specification, although it limited the crew total to seven, while the required maximum road speed was reduced to 30 mph (50 km/h). An armour basis had now been set, this being 30 mm at the front of the tank and 20 mm towards the rear, with the powerplant being a suitable petrol engine as an immediate requirement, with a comparable diesel engine being desired over the longer term.

This specification had been put before the 25th Meeting of the CIGS Research Committee by Martel, Hobart and Macready on 14th April. By this time Hobart had left the Tank Brigade in order to take up the role of Deputy Director of Staff Duties (Armoured Fighting Vehicles), or DDSD(AFV), this putting him in charge of the Staff Duties department SD7, which oversaw all aspects of AFV policy on behalf of the General Staff. This meeting was chaired by the CIGS himself, Cyril Deverell, and attended by Hugh Elles, Alexander Davidson, Ernest Squires, Noel Hudson and George MacLeod Ross. Also present were the Director of Military Operations and Intelligence (DMO & I), Major-General Robert Haining, the Director of Military Training (DMT), Major-General Alan Brooke, and the Director of Artillery (D of A), Major-General Henry Lewis. The meeting commenced with Elles demonstrating wooden scale models of the A11 and A12 Infantry tanks, and the proposed new Medium tank, which at 25 ft. (7.5 m) long and 9 ft. (2.7 m) high was a considerably larger vehicle. The MGO noted that it would be about the same size as the experimental Vickers A1 *Independent* tank of the mid-twenties, which had encompassed a main turret with a 3 pounder (47 mm) gun and four separate machine gun turrets. The meeting agreed to the provision of a seven man crew after acknowledging Hobart's ultimate preference for eight, and examined the various armament layouts without coming to any strict conclusions. The real differences in design philosophy emerged during a discussion on the armour layout, as Elles asserted that the utility of any tank as a gun platform depended not only on the effectiveness of the suspension, but also on the interplay between vehicle speed and the ground conditions. In consequence, he believed that there was little prospect of producing a vehicle that provided a steady gun platform at any appreciable speed in the near future. Elles was also dissatisfied with the armour layout, insisting that the 30 mm armour basis be extended to cover the whole tank, thus raising its weight by approximately 1.2 tons and slightly reducing its speed. He justified this proposal by inferring that the 20 mm armour in the vicinity of the engine compartment could be penetrated by numerous contemporary small arms weapons, although this was immediately

countered by Hobart, who argued that 100% protection against anti-tank weapons was unnecessary, and that the smaller calibre anti-tank weapons were unlikely to be encountered at the close ranges (circa 50 yards (~50 m)) these needed to penetrate 20 mm plate. Ernest Squires then sided with Elles, suggesting that the performance of anti-tank weapons would only improve in the future. This difference in opinion once again exposed the difference between pessimists like Elles and Davidson, who saw the tank as increasingly vulnerable, and optimists such as Martel and Hobart, who saw its salvation in speed and mobility. The CIGS himself adjudicated by stating that he was willing to accept a change in specification to an all round 30 mm armour basis, provided this did not result in an appreciable reduction in speed. Nonetheless, Alexander Davidson suggested that the requirement for a maximum road speed of 30 mph (50 km/h) be amended to a top cross country speed of 25 mph (40 km/h), this being agreed to by Deverell. The increase in the armour basis and other suggested modifications raised the estimated weight of the tank to approximately 27 to 28 tons.

As far as the procurement of the proposed Medium tank was concerned, Hugh Elles estimated a unit cost of £21,000, with production starting two or three years hence. He made no secret of his lack of enthusiasm for this machine, stating that he was prepared to accept it as a "long shot", provided that the meeting was "really satisfied that it was worth putting so many eggs into one expensive basket". He then stated his own preference for a lightened A12 with an armour basis of 30 mm and a maximum speed of 25 mph (40 km/h), estimating that three of these could be constructed at the same price as two of the proposed Mediums. Hobart countered by reminding Elles that the A12 only had a single (co-axial) machine gun, whereas a Medium tank required three machine guns, and that its suspension and transmission were only suitable for slow speeds. The A12's suspension utilised thirteen pairs of small diameter road wheels on each side of the tank, in a similar manner to the A11, although in the case of the later tank a "Japanese" suspension was employed instead of leaf springs, this being named after the arrangement employed on a Medium tank that Vickers had designed for export to Japan. Hobart therefore argued that to derive a Medium tank from the A12 would require substantially more work than merely reducing the armour. Deverell and Haining both pointed out that the urgent priority was an interim Medium tank (either the A7E3, A9 or A10), and that the development of an optimum Medium tank ought not to delay the introduction of the A12. The Committee therefore concluded that the Medium tank specification should be adopted, subject to the revisions agreed during the meeting, and that the design work for it be proceeded with as expeditiously as possible, as long as it did not hold up production of an interim medium tank or the A12. Meanwhile a proposal to order 60 A11's had been mooted, and on 15th April Kenneth Lyon minuted the DSD, Ernest Squires and the DGMP, Harold Brown, to inform them that the purchase of these tanks was being considered separately from the other Infantry, Medium and Cruiser tanks, which were not sufficiently advanced to be ordered.

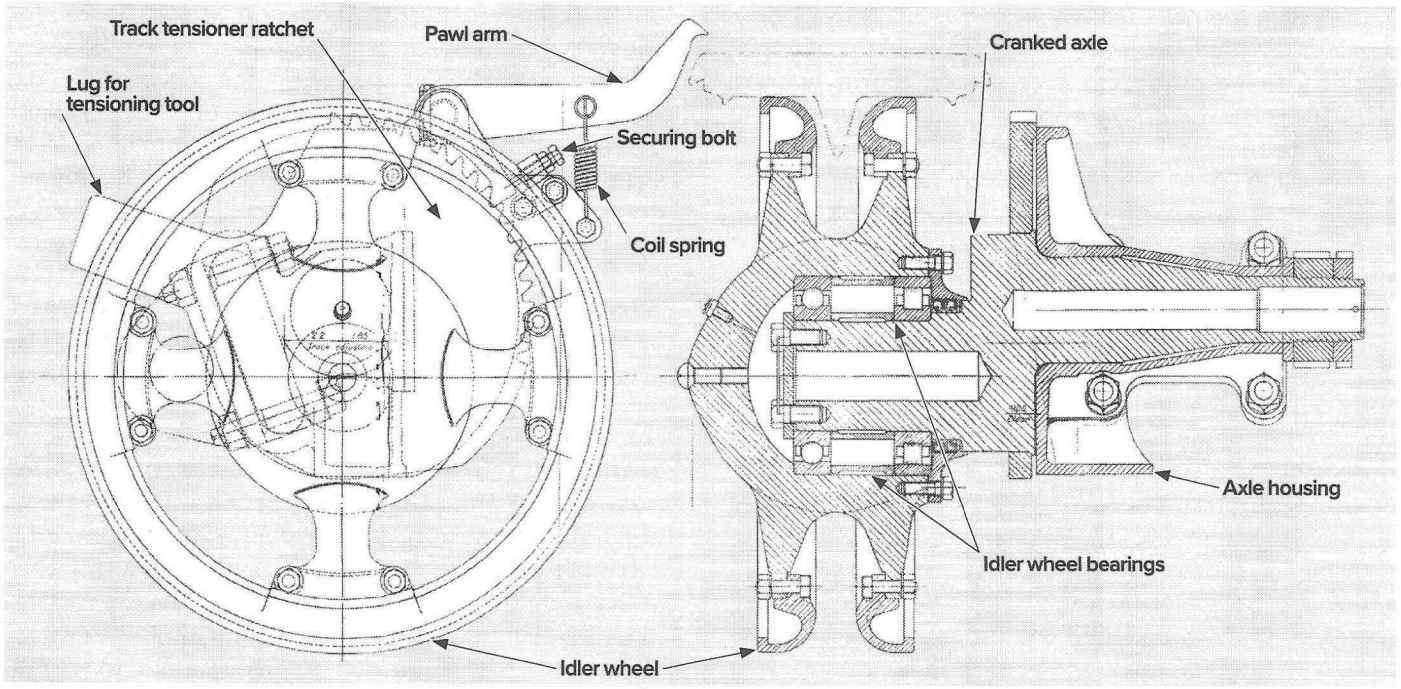
Regarding A11E1, MEE report A45/11 of 5th May provided an update on the condition of the third pair of tracks, which had now accumulated 500 miles (800 km), it being delineated that they had stretched by 4.13% although "No track pins or links have broken." Almost all of this mileage had been accrued across country, the total mileage of the tank now being 1859 (2991 km). On 20th May the War Office's 12th Progress Report confirmed that an order had now been placed for the 60 A11's, these being purchased under contract T4319. It was also confirmed that two prototype A12's were also being ordered, while "The Armoured Fighting Vehicle designs now outstanding are in respect of medium and cruiser tanks which depend upon further trials of pilot models now under modification or construction by the manufacturers." It should be recalled that War Office Memorandum No. 95 had posited a requirement for 833 Infantry tanks, but on 24th May the Deputy Under Secretary (DUS) at the War Office, Sir Frederick Bovenschen, minuted Harold Brown and Ernest Squires to inform them that an agreement had been reached with the Treasury that any initial provision would be limited to only 548 such tanks, this number including the 60 A11's that were already on order. This was due to the Treasury requesting that the 285 machines projected to cover war wastage be precluded until the War Office policy on reserves was more firmly established. In a similar vein, the number of Medium tanks to be ordered would now be held to 164 against a stated requirement of 247, the war wastage reserve for this class being 83 machines. Alexander Davidson acknowledged this restriction on 1st June, proclaiming to Ernest Squires that "It is noted that authority is now given for 164 Medium and Close Support Tanks and 548 Infantry Tanks." He further informed the Director of Staff Duties that he was working with Harold Brown to explore the production arrangements for the 60 A11 Infantry tanks. In the meantime, Mechanization Board Minute A2900 of 25th May had confirmed the order for two prototype A12's, these naturally being designated A12E1 and A12E2, with contract T3951 being placed with the Vulcan Foundry for their manufacture. These were referred to in the minute as being Heavy Infantry Tanks, it being confirmed that they would each be armed with a 2 pounder gun and co-axial 0.303-in. (7.7 mm) Vickers machine gun. Although it had initially been hoped that a sufficiently powerful single engine could be employed,

in the event the A12's motive power would derive from a pair of 6.75 litre AEC compression ignition (*i.e.* diesel) engines, these producing a combined power output of 190 bhp (140 kW). The engines would in turn drive a six speed epicyclic gearbox designed by the famed transmission expert, Major Walter Gordon Wilson, the resulting maximum speed of the estimated 23¾ ton machine being estimated at 15 mph (25 km/h).

During the morning of the 17th June, a meeting was held at the War Office to discuss the policy on the design and production of Medium tanks. The attendees included Hugh Elles, Alexander Davidson, 'Q' Martel and Frederick Gordon-Hall on behalf of MGO5, George MacLeod-Ross for the Design Department, and Joseph Hollebone and Leslie Carr for the Mechanization Board. Hollebone had just replaced Noel Hudson as the President of the Mechanization Board, this entailing a promotion to Colonel, with Hollebone effectively becoming Martel's right hand man. Leslie Carr (L.E. Carr) was one of the Design Department's civilian engineers, and was at this time on loan to the Mechanization Board, his main responsibility being liaison with the Vulcan Foundry over the design of the A12 Infantry tank. Also present at this meeting were Percy Hobart as DDSD(AFV), and Colonel W.D. Watson, who represented the Chief Inspector of Armaments. Hugh Elles explained that the priority was to decide which Medium tank should be productionised as soon as possible as a "stop gap", the only contenders being the A7E3, A9 and A10. Although Percy Hobart favoured the A9, the meeting did not come to any firm conclusions beyond advocating a comparative trial at the MEE. The discussion then turned towards the design of future Medium tanks, with Alexander Davidson admitting that adapting the A12 as a Medium tank with a 30 mm armour basis had been "definitely abandoned as impracticable, since the engine power available would be insufficient." The specification for the 28 ton "Medium Tank 1938 Class", as discussed during the meeting of the CIGS Research Committee on 14th April, had by this time been officially adopted by the General Staff as their "full" specification. However, the Design Department at Woolwich had produced preliminary drawings of a "simplified" Medium tank derived from this specification, which would incorporate a reduced turret ring diameter and a consequent saving in weight, while retaining the all round 30 mm armour basis. The outline drawing of this tank, DD(M) 1791, had offered it in two potential variations: the 'A' version, which would be reduced to 24 tons and require a five man crew, and the intermediate 25 ton 'B' version, with a crew of six. The 'B' variant would retain the two hull machine gun turrets of the full specification, while the 'A' variant would only mount a single such turret. Although the MGO5 representatives preferred to build the lighter 'A' version, which could be ballasted up to represent the performance of the 'B' model, Elles elected to build two pilot models to the 'B' specification, which would be given the appellation A14. The design work for these tanks was to be undertaken by the Vulcan Foundry, although after prompting from Elles it was also decided to order two pilot models to the full 28 ton Medium Tank 1938 Class specification, which would be designated as the A15, and be designed by the London Midland & Scottish Railway (LMS). Both the A14 and A15 were intended to be powered by the Thornycroft RY/12 V12 engine, derated to 500 bhp (370 kW), and feature a new design of transmission by Major Wilson's Self-Changing Gear Co. Ltd., which consisted of an epicyclic pre-selector gearbox with combined epicyclic steering units. Martel was relieved that at last some definite decisions had been made, claiming in retrospect that "We now had a definite policy, though there was no reason why this policy should not have been reached 6 months earlier." His frustration with what he saw as the obstructiveness of Alexander Davidson was expressed in the assertion that "If I had been working direct under General Elles I am sure this would have been achieved." Quite why he believed this was puzzling, as Davidson's scepticism toward any Medium tank not derived from the A12 had been entirely in consonance with that of the MGO.

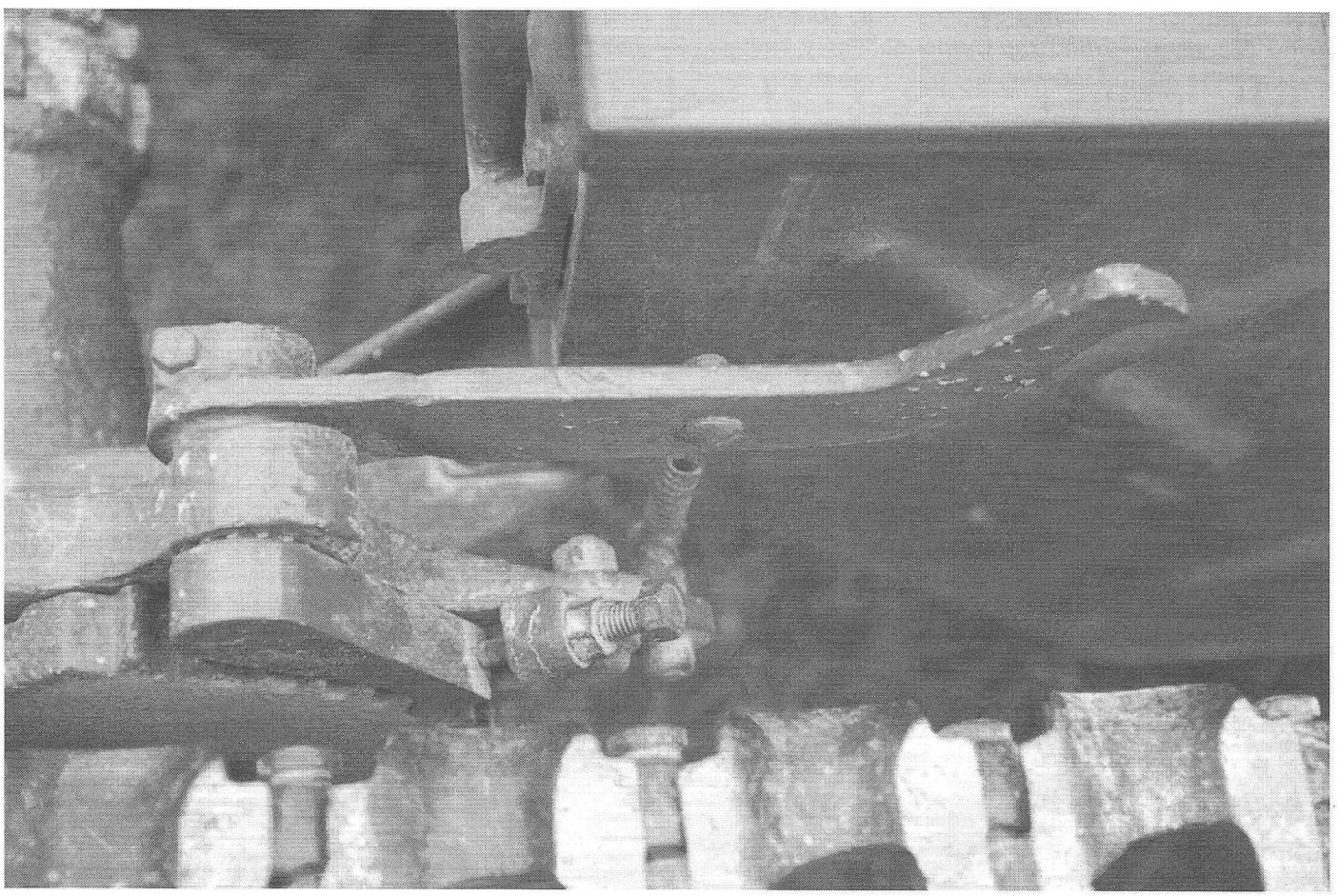
On 17th June MEE report A45/12 was compiled on the latest status of A11E1, the report noting that it had now accumulated 2041 miles (3284 km), with the third pair of tracks now having achieved 682 miles (1097 km), of which 110 (177 km) had been on road and 572 (920 km) cross country. It was recorded that "During this period, 5 pins on the near-side and 5 on the off-side track have broken and been replaced" and that "One plate on the near-side was broken and was replaced." All these defects would have occurred in the last 182 miles (293 km), as the tracks had been reported to be trouble-free for the first 500 miles (800 km). Three modifications had now been incorporated in A11E1, the first of these being the incorporation of a Vickers tank periscope in the driver's escape hatch, the equivalent item for the commander's hatch still being pending. It was acknowledged that "The vision is satisfactory for speeds up to which the vehicle is capable" although "The handles by which the periscope is tilted or swivelled on its ball mounting are unsatisfactory." The ball mounting for the periscope was located within the hatch plate between the lower (ocular) and upper (object) prisms, and facilitated the manipulation of the device by the driver, it being upheld that "A spade grip, operated by one hand, is required." The need for one-handed operation was obviously to allow the driver to operate the periscope on the move, it being commented that:

> The machine has covered 45 miles [72 km] road, 66 miles [106 km] cross-country (total 111 miles



(above) *Diagram of the track tension adjuster on the idler wheel assembly, the idler wheel and ratchet being rotated manually via the lug for the tensioning tool, and locked in place by the pawl and its securing bolt. Note that the idler wheel was provided with detachable rims.* *(The Tank Museum)*

(below) *Close up view of the track adjuster mechanism, showing the pawl and pawl arm are connected via a rotating spindle, and how the pawl is held down by the securing bolt.* *(Craig Moore)*



[178 km]) since the periscope was fitted. During this period, although the cross-country running was in very dry weather, no appreciable jamming of the ball through sand or grit has occurred. The ball is, however, very vulnerable to small arms fire.

It was furthermore attested that "The vision through the driver's vision slot is, of course, very limited, but it is possible, with practice, to drive slowly across country without using the periscope or opening up", although "Prolonged use of the slot is very tiring to the driver." The changing of the periscope prisms, as might for example be necessitated by the adherence of dirt or by their fracturing from small arms fire, was found to be impeded by the inaccessibility of the catch that facilitated the opening and hinging back of the lower half of the assembly. It was accordingly recorded that "It is understood that the makers intend to cut away part of the forward end of the ball to facilitate this operation." The second modification covered by report A45/12 was a new locking device for the idler wheels, this having been designed by the MEE themselves. Although the previous positive lock for the idler wheel adjuster had been deemed as satisfactory in the prior report A45/1, it had since been discovered that this could disengage when the front end of the tank, and thus the idler wheels, bumped down heavily after climbing a vertical obstacle. The new locking device consisted of bolted retainer that constrained the adjusting pawl that engaged in a series of teeth on the eccentric axle of the idler wheel. Although it was acknowledged that the new design "appears to function satisfactorily", it was related that Vickers intended to produce their own design that incorporated the same locking principle, this in fact positioning the locking mechanism parallel to where the pawl engaged the ratchet teeth. The lug for rotating the eccentric axle when adjusting the track had also been shortened, as "In its original form, this was apt to foul during obstacle crossing." The third and final modification was the substitution of the Zenith Type 42 VEIS vertical engine carburettor with a Solex Type 40 RZHG horizontal non-spillable carburettor in order to improve fuel consumption. A sixteen mile (26 km) road run conducted at an average speed of 6.4 mph (10.3 km/h) validated this assumption, with a figure of 2.3 mpg (0.81 km/l) being generated against the 2 mpg (0.71 km/l) that could be expected with a Zenith carburettor. Beacon Hill was climbed at a speed of 4.55 mph (7.32 km/h), this comparing with the 3.9 mph (6.3 km/h) achieved with the original carburettor. The Zenith carburettor was prone to flooding on steep inclines, and so a tilt test was arranged with the Solex type, this revealing a slight leak from the float chamber (which metered the supply of fuel to the injectors) when A11E1 was placed at a 30° downward tilt. There was also a slight leak from the float chamber when the tank was tilted 25° to the offside, this requiring the employment of a starter carburettor when restarting the engine. The warming up of the engine with the new carburettor was adjudged as "Fairly satisfactory", it being explained that "A sliding blanking plate is being fitted to the aperture between the radiator and the fighting compartment, to assist warming up."

MGO5 had instructed the MEE to conduct trials on the firing efficiency of the 0.303 in. Vickers Machine Gun, these being covered in MEE report A45/13 of 3rd July. A Mk. VI* version of the Vickers machine gun had been installed in A11E1, this having a left-hand feed instead of the standard right-hand arrangement, deriving from its location on the left of the dual (0.5-in./12.7 mm and 0.303-in./7.7 mm) machine gun mounting installed in the Light Tank Mk. VI. The gun was cooled from a one gallon (4.5 l) tank that was mounted in the rear of the turret, with the cooling water being fed, via an electrical pump fitted to the offside turret wall, to the water jacket of the machine gun. The circuit from the water tank to the electrical pump and then on to the gun, as well as the direct return to the tank, was all through flexible metal conduit. The report relayed that "The return pipe from the gun fouls the gunner's right hand during loading" and so "It should be repositioned to avoid this", while "The pump switch should be clearly marked to show the 'On' and 'Off' position." A preliminary trial was stopped through the fusee (*i.e.* recoil) spring of the gun becoming detached and jamming, with the trial itself consisting of the firing of 3000 rounds, these being distributed in thirteen belts, with the first twelve belts holding five groups of 49 rounds (245 in total) and the last belt holding the remaining 60 rounds (actually quoted as only 48). The temperature of the cooling water at the commencement of firing was 110 °F (43 °C), with the water boiling after ten minutes of firing, the report elucidating that "After this the water started boiling towards the conclusion of each belt, cooling off during the reloading." The first four belts were fired in 6 minutes and 55 seconds, these being followed by a 4½ minute pause while the gun was oiled, the remaining belts bringing the total firing time up to 35 minutes and 25 seconds. Minor stoppages had occupied 6 minutes and 27 seconds, and so the total firing time was declared as being 28 minutes and 58 seconds, although it is not clear whether the oiling interval had been included within the stoppage figure. The report submitted that:

> It is thought that the empty belts, which fall onto the floor of the tank and are difficult to pick up and stow rapidly owing to the confined space, would soon jam up in the rotating junction box and its support, if the turret was rotated to any extent during firing.

The "rotating junction box", more normally called a rotary base junction, was located on the floor of the fighting compartment directly below the turret, its upper rotating portion being connected to the turret by a support. This provided the electrical connections for the turret festoon lamp and the pump for the cooling system for the machine gun, as well as the junction for the voice tubes between commander and gunner. The feed mechanism to the gun had also generated some unease, it being found that the twin belt box carrier had a tendency to rotate. The normal carrier was a metal frame positioned in line with the feed block of the gun that held the container for the ammunition (*i.e.* the belt box), thus ensuring the alignment of the belt with the feed. However, the twin belt box carrier fitted to A11E1 held two belt boxes (or "liners") in a carousel arrangement, so that as one box was expended, the carrier's fixing pins could be released, allowing it to be rotated so that the second box came into alignment. However the fixing pins had tended to work loose during firing, allowing the carrier to swing of its own volition, and so it was suggested that these pins be spring loaded. Indeed, it was recorded that one of the pins had already broken. A roller had also been provided to facilitate smoother belt feeding, although the mounting brackets for this roller had been found to foul the gun when it was being mounted. It was nonetheless noted that Vickers were already attending to this problem. Of the fifteen Imperial pints (8.5 l) of water in the cooling system, three (1.7 l) had been lost from a leak at the rear of the water jacket of the gun, this being partly due to the inadequate union to the return pipe, and partly due to a badly fitting screw. It was additionally mentioned that "No parts were changed in the gun during firing, but the lock was oiled up three times", the lock being the loading, firing and spent cartridge extracting mechanism. Overall, however, it was concluded that "With the exception of the points noted above, the system appears to function satisfactorily. The gunner stated he was satisfied with his firing position." As well as the firing trial, MGO5 had also asked the MEE to conduct experiments to ascertain the best arrangement of the voice tube for intercommunication between the commander and driver. The first arrangement comprised a two-way voice tube, this being a single tube with a 'V' junction at each end to separate the mouth pieces and earphones. This proved to be unsuccessful, with MEE report A45/14 of 6th July remarking that "It was found that it was not possible to distinguish speech in either direction when the tank was on the move." It was therefore decided to test a one way voice tube, this enabling the commander to direct the driver. This was directed through the tubular support for the rotary base junction in what would become the standard arrangement, it being observed that "Speech to the driver from the Commander is just distinguishable if the driver's ear phones are correctly adjusted and firmly held to the ear by the straps." The voice tubes thus far evaluated had been been assembled from the War Department's standard Mk. VI tube, and so it was decided to construct an experimental arrangement from rubber hose pipe of 1⅛ in. outside diameter (OD), with ½ in. OD rubber tubing employed for the earphones, and a rubber mouthpiece of Royal Air Force specification. Report A45/14 recalled that:

> This type was a distinct improvement on the standard tubes but it is still necessary to adjust the earphones carefully. An improvement would probably be effected if the interior of the metal tube which acts as a support for the rotary junction box was rubber lined.

It was further submitted that if two way communication were desired, an additional one-way voice tube would be necessary to permit the driver to reply to the commander, this in turn needing a double tubular support for the rotary base junction. At this juncture A11E1 had accrued 2084 miles (3354 km), of which 1681 (2705 km) had been across country and 403 (649 km) had been on road. The all-steel road wheels for the No. 7 suspension station had still to be delivered by Chertsey, although the first experiments in barbed wire crossing were in the process of being carried out. Following the decisions taken at the meeting at the War Office on 17th June to discuss Medium tank policy, Hugh Elles briefed the 2nd Meeting of the Informal Army Council on 20th July. The Secretary of State for War was now Leslie Hore-Belisha, who had superseded Alfred Duff Cooper as Stanley Baldwin's Third National Government had been replaced by Neville Chamberlain's Fourth National Government on 28th May. In his new role Hore-Belisha was being advised by Basil Liddell-Hart, the close relationship between the two men being informally known as "the partnership". The MGO explained to the Council that "He had now seen the two Vickers' designs of the medium tank of which the second had only just appeared, a year behind time." These were of course A9E1 and A10E1, which were supposed to have been evaluated in a trial against A7E3 at Farnborough, although there was no reference to this latter tank in the meeting minutes, which otherwise emphasized that "It was impossible to combine the advantages of both and the Chiefs of the Imperial General Staff and he proposed to adopt the first mentioned model to the extent of ordering some 40 or 50. They would take a year to produce." This meant that the A9 had been chosen as the first "stop gap" tank, although Hore-Belisha was concerned that the delivery of these tanks would not begin for 12 months. The DGMP, Harold Brown, who was also in attendance, thought it would be very difficult to substantially reduce this wait,

which could only be done by disturbing other urgent work at Vickers. Hore-Belisha therefore directed that when the order was placed, the question of its priority in relation to the requirements of the other Services (*i.e.* the Admiralty and Air Ministry) should be put formally to the Minister for Co-ordination of Defence, Sir Thomas Inskip, and that this course should be followed with those other items of equipment that the Army totally lacked. Regarding the future A14 and A15 Medium tanks, it was reported that:

> Meanwhile the design was being worked out to the General Staff specification for an 'ideal' medium tank. This design and modifications on it did not go beyond the drawing stage. With the assistance of Vulcans, the L.M.S.R.Co., he hoped to develop these designs which would be valuable in war even if they were too expensive to produce in quantity in times of peace.

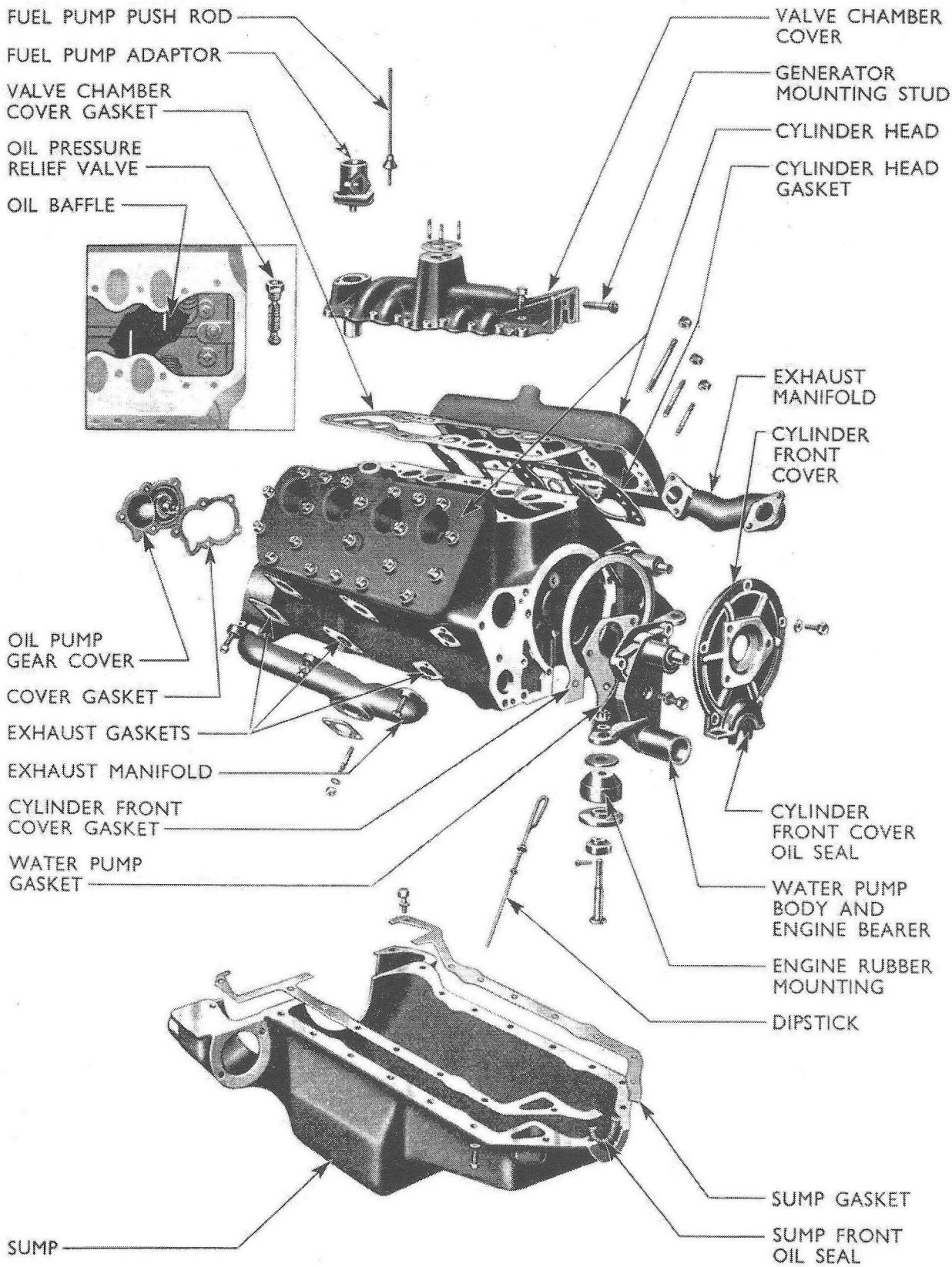
There was also another potential new Medium tank in the offing that had been conceived by Joseph Hollebone and 'Q' Martel, with the aid of Nuffield Mechanizations. This was the A16, which like the A14 was being developed to the DD(M) 1791 'B' specification, albeit with a similar Christie suspension to the A13 Cruiser tank. On 26th July War Office Memorandum No. 145 was issued, formalising the requirements posited in the previous Memorandum No. 95, these of course being for 833 Infantry tanks, 247 Mediums, and 350 Cruisers, including reserves for war wastage. The memorandum also alluded to the projected new models for the Medium tank class (*i.e.* A14 and A15), conceding that "The new models are likely to be considerably more expensive than the existing type but the exact effect on the programme cannot at present be foreseen". These new types would therefore raise the cost of the tank programme above the £17¾ million that had been estimated in Memorandum No. 95. It was also proffered that "In the meantime as the Tank Brigade at present possesses no Medium Tanks fit for war, it is proposed to place a minimum order of about 50 on the basis of one of the present experimental types (costing £11,000 to £13,000 each complete with guns and equipment)", this effectively giving advance notice of an order for fifty A9's as "stop-gaps". Memorandum No. 145 was presented to the 92nd Meeting of the Treasury Inter-Service Committee by Kenneth Lyon on 27th July. The meeting noted that the expansion of the tank programme delineated in War Office Memorandum No. 57, to the tune of £17¾ million, had now been accepted in principle by the Cabinet, and that the alteration in the balance of tanks put forward in Memorandum No. 145 did not affect the number required. As such, the 833 Infantry and 247 Medium tanks set down in Memorandum No. 145 equalled the 680 Infantry and 400 Medium tanks in Memorandum No. 57, both giving 1080 tanks in total. In addition the War Office would now explore the possibility of holding their war wastage reserve tanks as "manufacturing capacity", such that the major components for these vehicles would be manufactured and placed into storage, ready for assembly on the outbreak of hostilities. The meeting minutes outlined that:

> It was hoped to go to production for part of the new programme in the course of the year, but it was now necessary to proceed with orders for certain components such as gun mountings, power traverses and engines, which were common to all tanks and which took a considerable time to manufacture. Contractors were prepared to put down the necessary buildings and plant required for this purpose, but would not do so till they knew what orders they might expect.

In the case of the A11, none of the items mentioned were particularly pressing, as it was not fitted with a power traverse, only featured a comparatively simple single machine gun mounting, and utilised an engine that was already in mass production. Nonetheless, it was tendered that:

> Approval was therefore sought (1) to place orders for components for 548 Infantry tanks and 271 Cruiser tanks, (*i.e.* excluding war wastage reserves) and later to place orders for construction of the actual tanks and (2) to place orders for guns and ammunition for the complete programme of all three types of tank (*i.e.* excluding war wastage reserves).

The initiative to purchase 164 Medium tanks was being placed on hold while the A14, A15 and A16 designs underwent further scrutiny, although the sourcing of 50 tanks to the interim (A9) design was to continue. The Deputy Director of Staff Duties (DDSD), Brigadier Gordon Macready, also informed the committee that the guns and mountings should be ordered for the full total of 247 Medium tanks, as these could be utilised for whichever type of Medium tank was later chosen for adoption. At the prompting of Alan Barlow of the Treasury, the committee agreed to sanction the placing of orders for the components of the 548 Infantry tanks, 164 Medium tanks and 271 Cruiser tanks, and the subsequent manufacture of the Infantry and Cruiser tanks, but not the construction of the Medium tanks. They also agreed to sanction orders for the guns and ammunition for the full requirement of 247 Medium tanks, 833 Infantry tanks and 350 Cruiser tanks as well as the interim order for 50 Medium tanks, the approximate total for



Exploded view of the Ford V8 engine, this being an unusual design in that the valves were upside down and actuated by a camshaft located underneath them. The inlet and outlet ports were cast within the cylinder blocks, the "flathead" cylinder heads merely forming the upper casing of the combustion chambers. The four recesses in each head were the locations for the spark plugs. *(The Tank Museum)*

all the aforementioned items being approximated at £14,700,000. Most of the remainder of the financial layout of £17¾ million set forth in Memorandum No. 57 would be dedicated to the purchase of 360 Light Tank Mk. VI B's and 1617 Machine Gun Carriers. During July firing trials had taken place at Farnborough to determine the suitability of the machine gun mounting, these proving it to be satisfactory, although a few minor modifications were considered necessary. A11E1 would spend most of the month of August 1937 engaged in obstacle crossing trials, the obstacles themselves being of the "easily constructed" type, these comprising felled trees, double apron fences, and various arrangements of plain and barbed wire. Mechanization Board Minute A2872 of 7th September reprised that for the felled tree portion of the assessment, "a tree trunk 31" [79 cm] in diameter was successfully crossed at a point where the height above ground level was 36" [90 cm]." The standard double apron fence consisted of a line of vertical posts which formed the apexes from which plain wire fences were inclined both fore and aft, thus giving a triangular structure in the manner of a tent. Minute A2872 commented that:

> In negotiating this obstacle at right angles, the tank was able to clear itself of entanglement in a run of 10 yards [9 m] although a track was temporarily pulled off two of the top rollers. The gap made by the tank was suitable for the passage of infantry. Subsequently the tank ran over the 18 yard [16 m] length of the obstacle and demolished it without difficulty.

The first wire obstacle attempted was a "standard French concertina", a concertina being a wire coil that can be expanded to form a barrier when supported by fence posts, this particular example being a pair of coils arranged in two semi-circles six yards (5.5 m) apart. This proved to be a challenging impediment, as "On entering the second concertina the tank was checked and low gear had to be engaged and, although the vehicle partly cleared itself of wire in a short distance, the wire which remained adhering to the suspension was probably sufficient to cause damage in the course of a few miles." Trials were then conducted on extemporised obstacles constructed of plain soft wire of No. 4 and No. 8 Standard Wire Gauge (SWG), these equating to 0.232 in. (5.89 mm) and 0.16 in. (4.1 mm) thick wires. These were made up into four coils, with each coil consisting of thirteen turns of the No. 8 SWG wire and three turns of the No. 4 SWG wire at each end. The coils were arranged in two pairs so that A11E1 drove end-on over the full length of each coil, with each track effectively running over two coils. The Mechanization Board minute reasoned that "Coils of this wire 5' [1.5 m] in diameter did not appreciably check the tank, but the amount of wire picked up would probably have caused damage in the course of a few miles." However, the most impregnable obstacle would prove to be both plain and barbed Dannert wire, which was an oil-tempered barbed wire of high grade steel developed by Horst Dannert in Germany, and was sufficiently rigid to be arranged in self supporting concertinas and therefore be quickly deployed by infantry in order to form an expedient barrier. An individual Dannert wire concertina could be compressed into a coil that was capable of being carried by a single man, while stretching to 50 feet (15 m) on deployment, and needing only three fixing points to be held in position. The particular wire employed in this trial would be 0.118 in. (3.00 mm) in diameter, with the coils having a 3 ft. (1 m) diameter, its tensile strength being 82.5 tons/in^2 (12,700 MPa). In this instance, the obsolescent Medium Tank Mk. II and Light Tank Mk. IV were employed as comparators, with the obstacle for A11E1 consisting of six rows of wire placed nine yards (8 m) apart, the first and fourth rows being of barbed wire and the other rows being of plain. Minute A2872 relayed that:

> This wire proved most effective and constitutes a formidable obstacle to Tanks, Infanry, Mark I; Tanks, Medium, Mark II; and Tanks, Light, Mark IV. All attempts by these types failed to negotiate the wire successfully. In the case of the Tank, Infantry, Mark I most of the wire was caught by the track and suspension and dragged over the ground. Travelling in this manner for 50 yards [~40 m] the tank turned through 180° and continued on its course. After a distance of 20 yards [~20 m] two bogie wheels jammed. The trial was then concluded and the wire cleared by oxy-acetylene cutting. This work occupied four men for one hour.

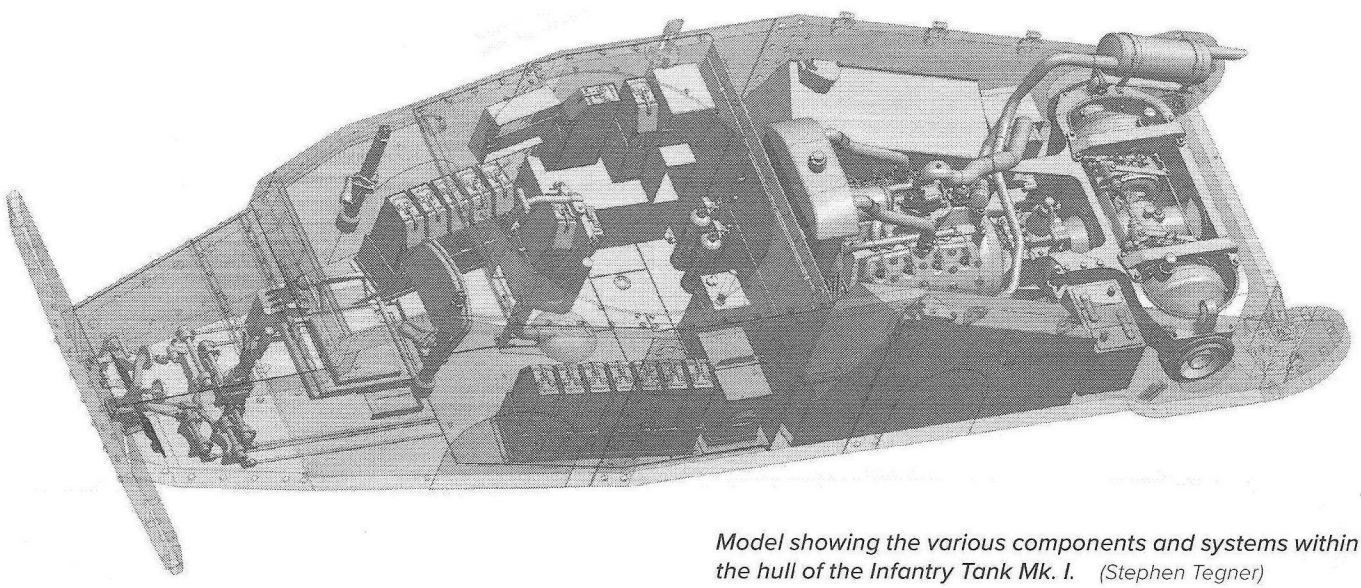
A series of impromptu tests had also been conducted in order to configure a device for combating wire obstacles, the Mechanization Board disclosing that "Experiments with a locally constructed throw-off bar for attachment to the front of Tank, Infantry, Mark I, A.11.E.1 have proved this to be ineffective against Donaert [*sic*] wire obstacles in its present form." However, it was also acknowledged that "In the case of plain wire obstacles the throw-off bar assists in pushing down the wire and allowing the tank to pass over the obstacles." This bar would have been jettisoned from the front of the vehicle in order to depress the wire coils, thereby aiding its subsequent traversal of the obstacle. The Mechanization Board recommended further trials in order to refine this device, as well as the adoption of Dannert wire for service use. Alexander Davidson had also asked the Mechanization Board to evaluate a Vokes-Blanvac cone-type exhaust

silencer which was commercially available for the Ford V8 engine. According to Mechanization Board Minute A2874 of 12th September, the Vokes-Blanvac silencer impaired fuel consumption at 6.4 mph (10.3 km/h), giving a figure of 1.8 mpg (0.64 km/l) against the 2 mpg (0.7 km/l) of the standard silencer. The speed of a climb up Beacon Hill was also slightly reduced, from 4.6 mph to 4.5 mph (7.4 km/h to 7.2 km/h). The noise attenuation was also worse, producing 68 British Standard phons at 6 mph (10 km/h) in comparison to the 66 BS phons of the standard device, a phon being a logarithmic unit of loudness. The difference was particularly marked when the throttle was closed with the vehicle stationary, the Vokes-Blanvac design emitting 40 BS phons against the 33 BS phons of the standard silencer. The Mechanization Board therefore recommended that this silencer should not be adopted for service use.

As well as being the Assistant Under Secretary of State for War, Kenneth Lyon was also the War Office's Director of Finance (DFC), and it was in this latter role that on 11th October he contacted the Director-General of Munitions Production (DGMP), Harold Brown, and the Director of Staff Duties (DSD), Ernest Squires, in order to air some concerns that had been expressed by the Treasury toward the A11 Infantry Tank. These concerns had derived from the fact that the War Office had informed the Committee of Imperial Defence's Defence Policy Requirements (DPR) committee that only 60 A11's had been ordered because "the design was not considered entirely satisfactory." This statement had alarmed the Treasury, as they had now sanctioned orders for 548 Infantry tanks, as well as the guns and ammunition for a potential 833 such machines, and appear to have been unaware that the more advanced A12 design was also in gestation. Percy Hobart, as the DDSD(AFV) would respond on behalf of Squires on 13th October, informing Lyon that "The position with regard to the 'I' tank is similar to that of the Medium of which a limited number (50 A.9's.) have been approved for order." He then assured him that:

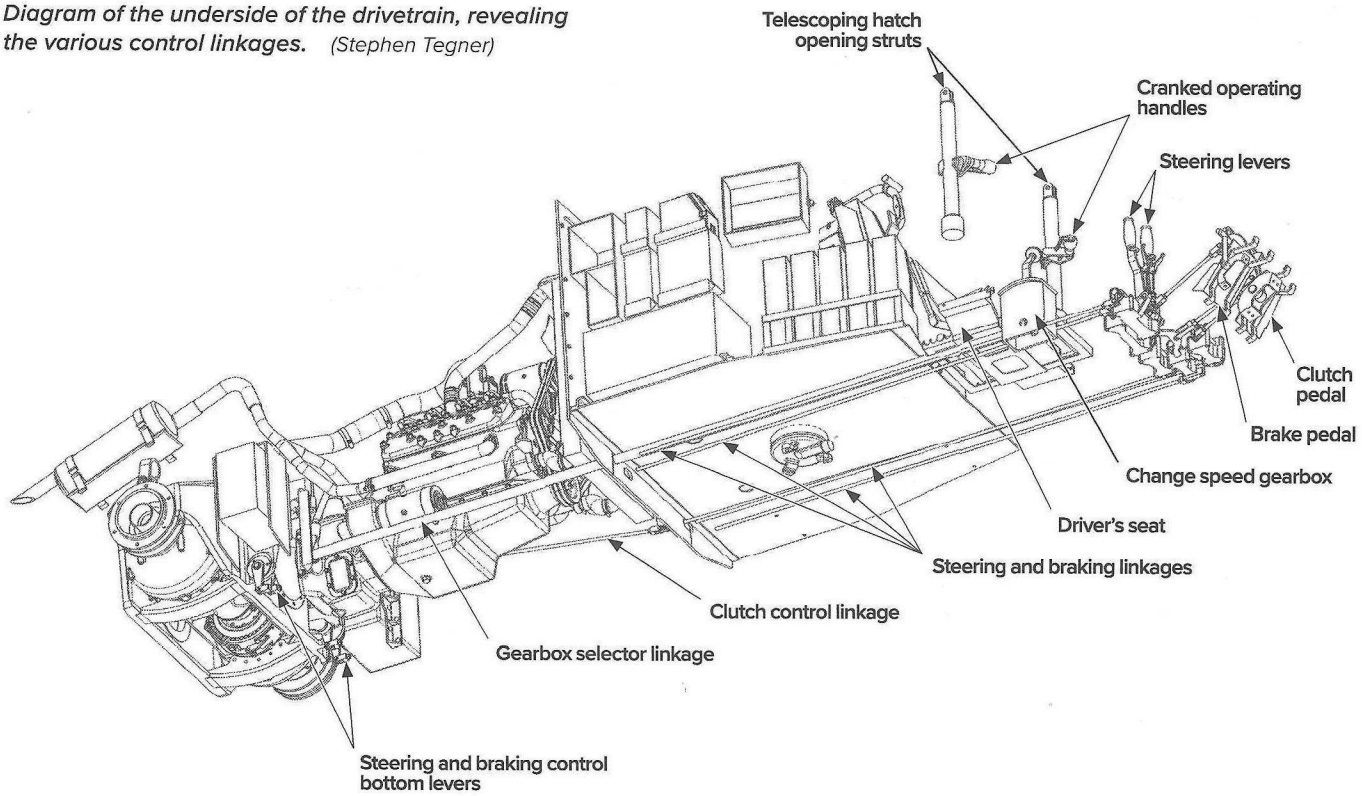
> The pattern of 'I' tank being ordered under this authority is, like the Medium A.9., the best of its type that has so far been developed. Of its type it can be said to be a success. Meanwhile, however, the development of a better type is in hand. If this development had been further advanced, it might not have been necessary to order the present type. In the uncertainties of the situation, however, it is essential to go to production with the best type immediately available. Later orders will be for a better type.

This effectively confirmed the status of the A11 as an interim type that was only being sought in lieu of the final development of the A12, with the remaining tank and component orders expected to be for the latter machine. Kenneth Lyon accordingly advised Edmund Compton of the Treasury, pointing out that "The required 60 will count against the establishment, though of course will be the first to be replaced when this becomes necessary", this being accepted by Compton on behalf of the Treasury. A bombshell would strike the upper echelons of the Army at the beginning of December, when Leslie Hore-Belisha made his move against the Army Council, removing three of its four military members in the persons of the CIGS, Cyril Deverell, the Adjutant-General, Harry Knox, and the MGO, Hugh Elles. Only the QMG, Reginald May, would remain, with Knox being replaced by General Sir Clive Liddell and Deverell giving way to Field Marshal John Vereker, the Viscount Gort (Lord Gort).



Model showing the various components and systems within the hull of the Infantry Tank Mk. I. (Stephen Tegner)

Diagram of the underside of the drivetrain, revealing the various control linkages. (Stephen Tegner)



Elles would not be directly replaced, as the post of MGO would be abolished and its duties passed to the DGMP, Harold Brown. This gave Brown the formidable burden of producing an entire suite of modern weaponry for the British Army in as short a time as possible, and his immediate concern was not tanks, but guns. These included the development of the 25 pounder field gun, the 3.7-in. (94 mm) anti-aircraft gun, and the 4.5-in. (114 mm) howitzer; the production of the 2 pounder (40 mm) anti-tank gun; and the licensed manufacture of such foreign-designed weapons as the Bofors light AA gun and the Bren light machine gun.

For his immediate subordinate, Brown would appoint Major-General Maurice Taylor as the Deputy Master-General of the Ordnance (DMGO). Taylor had originally been the favourite to replace Hugh Elles as MGO, and his new title had been selected so as to maintain the possibility of resurrecting the role of MGO in the future. 'Q' Martel claimed to have been particularly upset about the removal of Elles, deeming it "a real tragedy", as "His ability had remained unquestioned." Martel had characterized the tank organisation under Elles as being "horizontal", in that it had consisted of a number of separate fiefdoms that failed to properly integrate, and was taking advantage of this period of flux in order to push his own proposed "vertical" reorganisation. This would entail the Director of Mechanization controlling two deputies (DDM's), one of whom would oversee tanks and mechanical transport, while the other would control Signals and Royal Engineers equipment. These roles would encompass both development and production, with Martel (who had now been promoted to Brigadier) taking over the former position as DDM(V), effectively running the tank programme. The intention appears to have been to reduce Alexander Davidson to a figurehead role, although the Director of Mechanization had not been fully neutralised, Martel frustratedly referring to him as a "fifth wheel". As a corollary, Martel wanted to reform the organisation at Woolwich, so that the 'M' and 'V' sections of the Design Department came under the control of the Mechanization Board to form a single establishment. Some light on the intrigues involved in the dismissal of Elles was shed by E.M.C. Clarke in a letter to George MacLeod Ross of 8th December, as he recalled a conversation he had conducted with 'Q' Martel at the Army's Staff College at Camberley in Surrey. According to Clarke, Martel had been "buzzing round at the Staff College, full of his ghastly organisation" when he provided Clarke and the college's commandant, Major-General Ronald Adam, with an insight into his relationship with Elles:

> Martel said that 'Hugh' had thought that he had been rather disloyal by discussing with Liddell-Hart the M.G.O. organisation. Martel met L.H at a dinner and in answer to the latter whether the M.G.O. branch wanted re-organizing had been 'quite frank'. In other words I suppose he was pushing his vertical organi-

sation. What he said was that he merely described the better method, which 'Hugh' had tried, but failed to put through 18 months ago, and therefore there was no disloyalty.

Liddell-Hart was of course "in partnership" with Hore-Belisha, and was also a confidant of the senior RAC commanders most eager to see the removal of Elles, so even the slightest criticism of the MGO by Martel would have had severe ramifications. Clarke added that:

> The background to this volunteered story is that H.B. is commonly reputed to be in the constant company of L.H. and that the push to get rid of the eminent Councillors has been well-known to have been continuous for at least two months. I don't think Martel would be consciously disloyal to Elles ('poor Hugh'), but he has a fine instinctive perception of the way the wind is blowing.

The "eminent councillors" were of course the three ejected members of the Army Council, who it should be recalled had first been criticised in Liddell-Hart's recollection of the RTC Dinner of November 1936. As such, the removal of Deverell, Knox and Elles had represented something of a coup for Liddell-Hart and the Royal Tank Corps. Clarke attributed Martel's faux pas to his guilelessness, commenting that "I should loathe to have him on my side in a tight corner in case he might change sides in order to give me more room to fight — what's more, he would really believe it." This was a characteristically waspish comment from Clarke, who rarely had anything complementary to say about his peers. He additionally informed MacLeod Ross that "Elles has behaved admirably according to Mac, and has been doing his best to help his successor. If this was the case, his exit will have been more admirable than his tenure of office." The "Mac" referred to here was Colonel Albert Macrae, who had superseded Colonel Bishop as the Superintendent of Design at Woolwich, and who had accompanied Clarke at a dinner at the end of October in which an inebriated Elles had embarrassed himself in front of Leslie Hore-Belisha. Clarke considered that this latter incident had sealed Elles' fate, recounting to MacLeod Ross that:

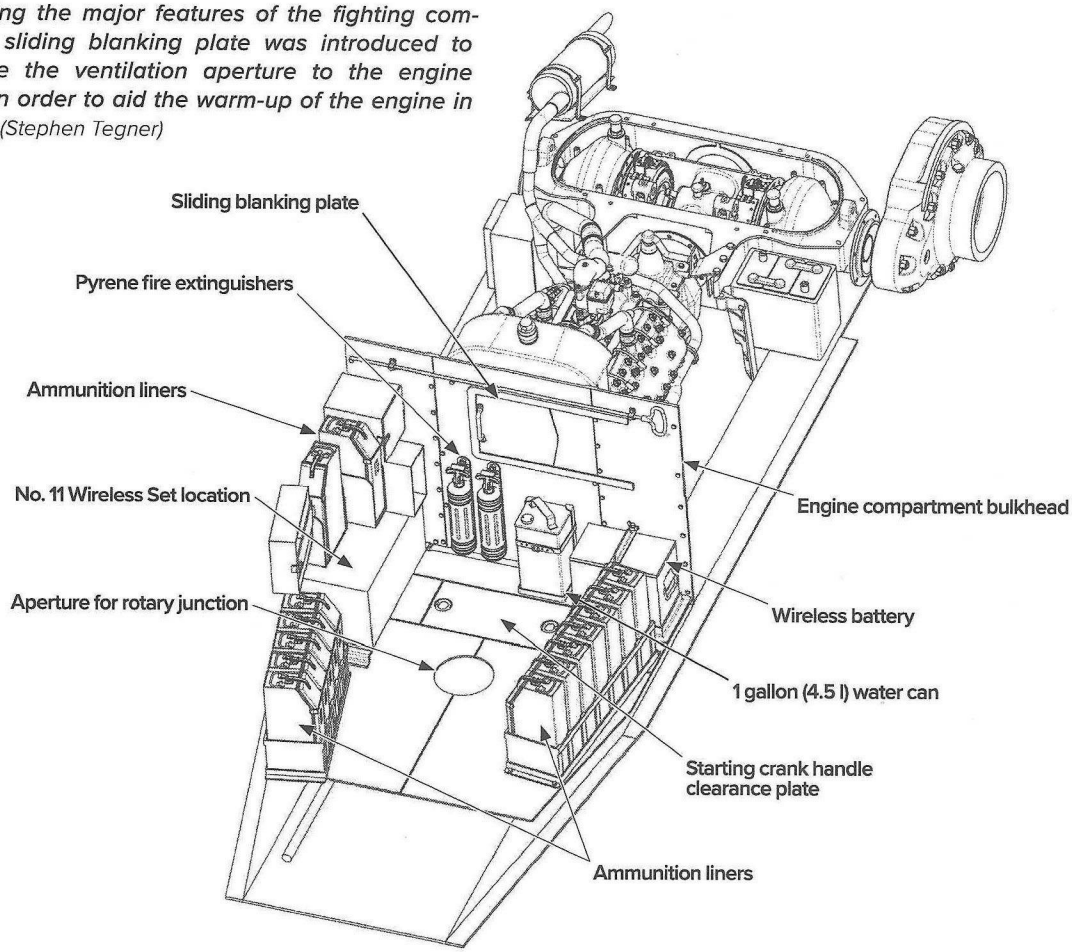
> we both suddenly realised that H.E. was more than somewhat soaked. He remained quite genial and completely woolly, but our difficulty thereafter was to disengage ourselves from his rambling platitudes and wagging forefinger. Frankly I think he won by sheer alcoholic imperviousness, but, remembering the forefinger wagging I had seen at dinner in Hore-Belisha's face, I wondered afterwards whether he hadn't lost his own battle a little earlier for the same reason.

George MacLeod Ross could not, however, take any delight in these events as he was viewed by 'Q' Martel as an obstructionist and would be promptly replaced as Deputy Superintendent of Design by Colonel W.D. Watson. The new design organisation envisaged by Martel at Woolwich was to be headed by the faithful Joseph Hollebone, with the Mechanization Board gradually absorbing the duties of the Design Department's 'M' section, thereby ultimately creating a single AFV design and development establishment. Elsewhere, Percy Hobart had been replaced as DDSD(AFV) by Brigadier Frederick Hotblack, with Hobart himself being promoted to Major-General and replacing Alan Brooke as the Director of Military Training (DMT). Brooke in turn would assume the command of the new Mobile Division, which had been officially formed on 24th November 1937, while the command of the Tank Brigade, which was now confirmed as a component of this division, passed to Brigadier Justice Tilly. Perhaps the biggest surprise of all would be that Harold Brown would promote E.M.C. Clarke to become the Director of Artillery, this being a setback for any attempt by Vickers-Armstrongs to sell their guns to the Army, as Clarke had scant regard for that particular firm. Meanwhile at Farnborough, A11E1 had been fitted with the steel road wheels for the No. 7 suspension stations, with MEE report A45/15 of 23rd December chronicling that:

> The machine was run on roads and across country for approximately 50 miles [80 km], and swinging tests were carried out on the Sandy Nullahs area. The track tongues have not again jammed between the rim and the rubber on Nos. 5 and 6 wheels, nor has any defect occurred which could be attributed to the use of metal bogie wheels in lieu of rubber.

By this time the tank had chalked up 2334 miles (3756 km), of which 1851 (2979 km) had been across country and 483 (777 km) on road, the report affirming that "There is no apparent increase in noise due to the steel wheels — the scream from the final reduction gear effectively drowning out other noises." It was purported that "The engine, which has now completed 1184 miles [1905 km], is in need of an overhaul and a spare engine will, therefore, be fitted as soon as possible." This would be the third engine installed in A11E1, the first engine having been replaced at 1150 miles (1850 km) due to the failure of the gudgeon pins for two of its cylinders. It could therefore be inferred that the overhaul life of the Ford V8 in the A11 was in the region of 1200 miles (2000 km).

Diagram showing the major features of the fighting compartment. The sliding blanking plate was introduced to optionally close the ventilation aperture to the engine compartment, in order to aid the warm-up of the engine in cold weather. (Stephen Tegner)



On 23rd December the new CIGS, Lord Gort, called a meeting in his room at the War Office, attended by Harold Brown, Maurice Taylor (as DMGO), Alexander Davidson, Ernest Squires, Robert Haining, and 'Q' Martel. Gort announced that the object of the meeting was to settle the types of tank required in the near future, and the organization of the tank battalions in which they would be employed. This needed to be clarified so that the DGMP could arrange his production orders and the DSD proceed with his conspectus (*i.e.* preliminary overview) of the personnel requirements. However, this was only the ostensible justification for the gathering, and the real reason was to coordinate a response to the "New Army Policy" that was being prepared by Leslie Hore-Belisha, which was seeking to extract large savings from the Army Estimates (*i.e.* the Army's budget), with a major portion being expected to come from the tank programme. This policy was ultimately being driven by Neville Chamberlain and the Treasury, who were seeking the elimination of the "Continental commitment" in favour of Chamberlain's preference for "limited liability". In this latter scenario, Britain would avoid the enormous financial costs and casualties that it had incurred during the previous war by concentrating its resources on the Royal Air Force and Royal Navy, rather than on a large Field Force for France. The originator of this dubious strategy was Basil Liddell-Hart, whose book *The British Way in Warfare* had argued that Britain should readopt a businesslike approach to war, centred on economic pressure enforced by sea power. This argument had gained force following the contraction of the British economy during the Great Depression, which had reduced the nation's industrial capacity (and consequently its revenue) such that it was no longer possible to build up the three armed services to meet all anticipated challenges. Accordingly, the minutes of the meeting stated that:

> [CIGS] said that before we could lay down a policy, we must make up our minds against whom we were most likely to fight, in the event of war in the near future. Now that the continental commitment was cut out, the Middle East was undoubtedly the danger spot.

The identification of the Middle East as a potential area for conflict was something of a ruse, the main intention simply being to preserve as much of the existing tank programme as possible from Hore-Belisha's cuts. Nonetheless, Robert Haining was one attendee who

was keen to develop this scenario, advocating that "the Middle East was the great danger, and that therefore the first thing we wanted was something to meet an Italian advance through Libya." Haining envisaged the employment of air power supported by mechanized forces, while "Later on, if the war were to spread to Europe as might well occur, we should want medium tanks; but our participation on land in Europe could not take place for some considerable time." Lord Gort was of a similar mind, this line of thinking pointing to the employment of mechanised cavalry equipped with Light tanks and machine gun carriers, supported by a limited number of Cruiser or Medium types. The scope of action was necessarily unambitious, with Gort outlining that:

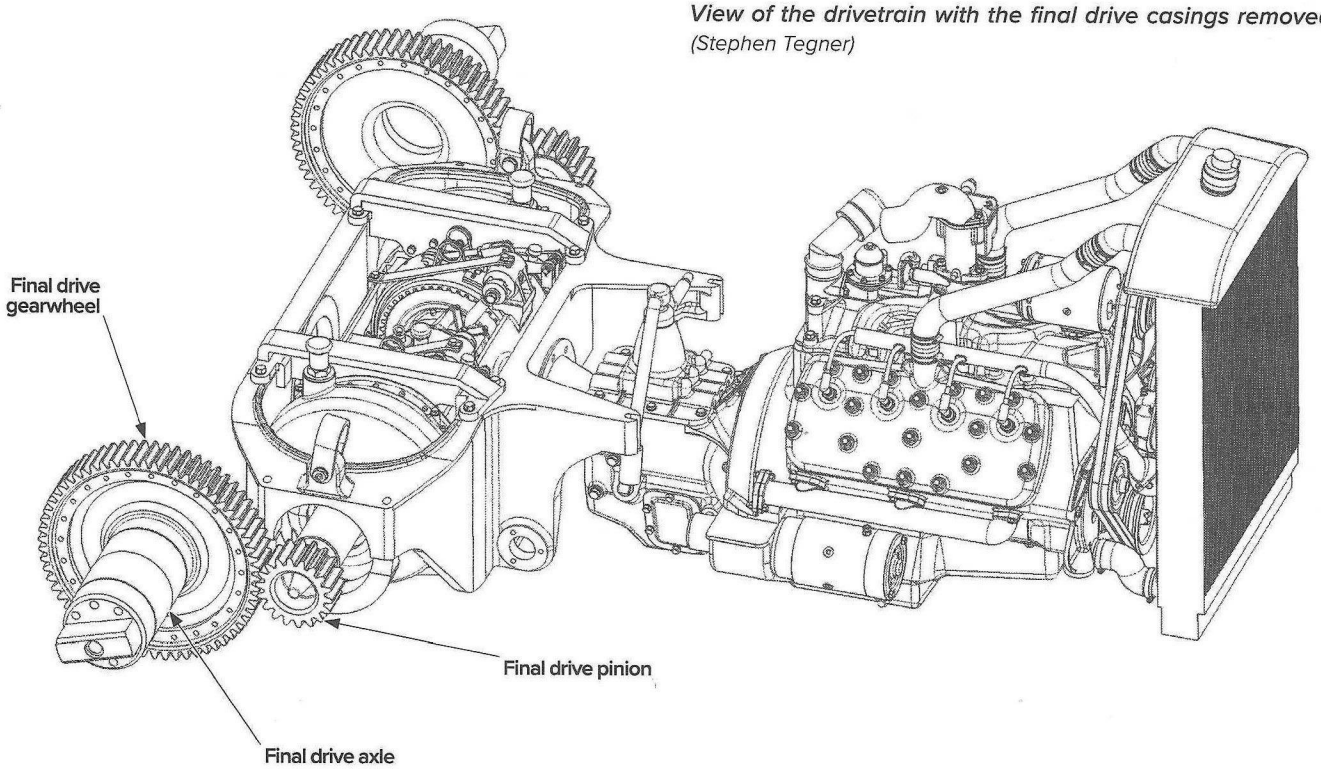
> In his opinion the role of the British Army at the outset of a war in the Middle East would be a defensive one, with of course local counter-offensives: we must think of the effect of this role on the number of different types of tank we require; of course the fewer types we need, the easier our maintenance problem becomes.

Gort pointed out that with the absence of the Continental commitment, it would now be possible to permanently station tanks in Egypt in peacetime. However, even if a useful role could be found for armour in the Middle East, the opportunity to make savings would still need to be pursued, and Ernest Squires argued that the present organisation of tank battalions was too large, and expressed his preference that any tank force earmarked for the Middle East should consist of three battalions of 45 tanks each (instead of the current 50 mixed Cruiser and Medium tanks), with each battalion comprising three companies. As well as the combined 135 tanks within these three battalions, there would be an additional 15 for training and a holding of 100% reserves, thus giving a total of 300 machines. Squires posited that this reduction in numbers could be offset by the employment of more powerful tanks, and stated that "The reserves previously asked for were 150 per cent, but this number could be cut down if a certain number of tanks were stationed in Egypt in peace." The original 150% reserve estimate had included both unit reserves and war wastage, and as far as the latter were concerned, these had yet to be granted Treasury sanction. As for the production of new tanks, the CIGS stressed that:

> We must at the same time reconcile our ideas with the practical necessities of the case — both tactical and financial. Time is the essence of the problem, as after the end of 1939 there may be quite a different outlook on matters military. We must get what we can, rather than what we like.

He further underlined that "The main point was to get something quickly, and we had to decide now the type of tank whose production could be accelerated, and how this could be done." Harold Brown reminded the meeting that in the event of war in the near future, there would be no new medium tanks available, except possibly a proportion of the 50 A9's ordered as a stop gap. Brown had formed the impression that the General Staff considered the A9 to be of less value than the A11 Infantry tank due to its relatively light armour, and so he requested the authority to reduce work on the A9 and give preference to the A11. He also wanted to develop the A12 as fast as possible, by placing orders "off the drawing board" before any prototype trials, and reducing any such trials to the minimum necessary. Maurice Taylor claimed that the A12 was sufficiently powerful that twelve of them were at least equal to fifteen A11's, although this grossly underestimated the improved fighting capacity of the latest machine. However, it did allow Taylor to make the case that the same fighting strength could be attained with a smaller number of tanks, although the significant cost differential between the A11 and A12 went unmentioned. The various tank classifications were discussed, and it was decided that it would be better to reduce the types available for order to three, until a "suitable" Medium tank was evolved. This meant that the Medium classification would be temporarily eliminated, with the A9 in "effect being a slow cruiser tank." For the Cruiser tanks proper, it was decided to order 50 A13's in January 1938, while prototypes of both the A14 and A16 would be produced, the responsibility for the A14 being transferred from the Vulcan Foundry to the LMS. The classification of the A14 and A16, having originally been "Fast Medium", was now mutating into the new name of "Battle Cruiser", this being more reflective of a desire for terminological, rather than tactical, consistency. In the meantime, the decision was taken to cease all work on the A15. As far as Infantry tanks were concerned, it was decided to order 65 A12's at once, and request Treasury authority for another 60 Infantry tanks, either A11 or A12 depending on which could be produced soonest. All these would be in addition to the 60 A11's that had already been ordered in May. The Fourth Report of the Mechanization Board, of 31st December 1937, would provide a brief summary of the progress made on A11E1, recounting that:

> The total mileage accomplished during the year was 2,334 [3756 km], and the performance and reliability of the vehicle have been entirely satisfactory. The tendency of the tracks and sprockets to collect stones and cause damage to the idler wheel spindles



View of the drivetrain with the final drive casings removed. (Stephen Tegner)

and track pins has been eliminated by altering the rear bogie brackets to increase the height of the sprocket centres by 5 inches [13 cm]. On production machines this will be achieved by an alteration to the design of the final reduction gear casing. The substitution of a Solex dust-proof carburettor type 40 R.Z.H.G. for the original carburettor has resulted in an increase in speed, with a lower petrol consumption. Satisfactory vision at the required tank speeds under fighting conditions has been achieved by the provision of a specially designed periscope.

The most notable comment in this passage was the intimation that for production machines the increase in sprocket height would be achieved by rotating the final drives rearwards, as had been suggested during the early stages of testing, the report adding that "This obviates the abnormal fracture of track pins by increasing the slope of the rear portion of the track and providing additional elasticity." A short update was also given of the A12 design, as follows:

Towards the end of last year consideration was given to the evolution of a more powerful, faster type of tank than A.11.E.1, designed to lead an assault on a defensive position and to co-operate with infantry. A contract has been placed with the Vulcan Foundry, Ltd. for the design and production of two pilot models, the first of which was nearing completion at the end of the year.

On 3rd January 1938, Harold Brown minuted Frederick Bovenschen, asking him to implement the decision to order the 65 A12 tanks as agreed at the meeting in CIGS's room on the 23rd December, this being covered by the Treasury sanction given at the 92nd Meeting of the TISC on 27th July. The DGMP further confirmed that he had now given orders that production of the A11 should take priority over the A9. Brown also used this occasion to inform the DUS that he was placing an order for 65 A13's forthwith, an increase on the 50 proposed at the meeting in CIGS's room, and was arranging for the LMS and Nuffields to provide prototypes of the A14 and A16 as soon as the designs were ready. Work on the A15 had indeed ceased, with the mock-up that had been prepared at Woolwich being disassembled in order to be reconfigured as the A16. Bovenschen, in a response of 4th January, noted that there were no financial problems with the 60 additional Infantry tanks being either A11 or A12, and enquired as to whether the decision to prioritise the A11 over the A9 meant the cancellation of the latter tank, Brown assuring him that "It is not intended to cancel the orders for A.9, but merely to give preference to work on A.11." With the departure of Hugh Elles it had been widely expected that Harold Brown would appoint a new Director of Mechanization, but to the surprise (and indeed disappointment) of many, Alexander Davidson would retain his position. This in turn secured

the future of the Infantry tank concept, although the DGMP was not satisfied with progress on the A12, and would turn to Vickers-Armstrongs to suggest an alternative. This was evinced in a letter of 5th January 1938 from Commander Robert Micklem, the General Manager of Vickers' Elswick Works in Newcastle upon Tyne, to Sir John Carden's former business partner Vivian Loyd. The letter divulged that "Sir Harold Brown has again asked me to consider the possibility of evolving a machine" that was "Somewhere between Matilda and the Vulcan machine without the appalling expense and complications of the Vulcan machine." There were two major issues with the A12, the first of these being that the armour was formed from large castings of complex shape, especially in the case of the outer side plates that protected the suspension, which required a significant amount of fettling and dressing prior to fitting. This had to be done by hand, such that the labour employed in the construction of an A12 was a magnitude higher than for any other tank model then in consideration. Indeed, later estimates would approximate that an A12 required 31,000 manhours to produce in contrast to the 18,000 hours of an A10. The other important aggravation was the A12's proposed Wilson epicyclic gearbox, which required extensive development and would also need a firm of precision engineers to undertake volume production.

In order to address his anxieties regarding the direction of Infantry tank development, Harold Brown called a meeting in his office on 12th January 1938, this being attended by Maurice Taylor, Alexander Davidson, and 'Q' Martel, as well as Robert Micklem of Vickers-Armstrongs. As General Manager at Elswick, Micklem also had responsibility for the development establishment at Chertsey, and he had brought with him the Chief Engineer at Chertsey, Leslie Little, as well as Vivian Loyd, who had been retained by Vickers. However, Little and Loyd were not privy to the initial discussions, being made to wait outside Brown's room until summoned. The DGMP began the discussion by asking Micklem about the production situation at Vickers generally, the firm having two facilities in Newcastle to produce tanks, these being the Elswick and Scotswood works. Brown wanted to know whether the firm would be able to manufacture A11's during 1939 in addition to their orders for Light Tank Mk. VI B's and fifty A9's, and if this were not possible, how much their output of the latter tanks would need to be reduced in order to accommodate the production of one A11 per week. Micklem was tasked with producing a report on this matter, and asked to consider hiving off the production of Dragon artillery tractors to India if this were feasible, in order to free up capacity in Newcastle. The DGMP then turned to the matter of the design of the A11, and how it could be adapted in order to satisfy his prior request for an Infantry tank midway between the A11 and the A12. The minutes of the meeting recorded that "Commander Micklem pointed out that it would be comparatively easy to make a slight increase in the size of the turret to hold two machine guns, but more than a total of two men could not be accommodated without very material alterations to the tank." This was pertinent in that a three-man turret was deemed necessary to operate a 2 pounder gun, which required a dedicated loader in order to be used to its full efficiency. The War Office representatives also offered the suggestion that the A11 would benefit from a small increase in its maximum 8 mph (13 km/h) speed. In order to address this, Micklem called Vivian Loyd and Leslie Little into the meeting, the minutes recapitulating that:

> Mr. Little expressed the view that if the engine was increased in power the increase tended to become cumulative, *i.e.* heavier transmission was needed and the increased size meant an increase in weight in armour. He considered that an increase in speed could only be obtained by complete redesign of the tank.

It should be recalled that A11E1 had achieved just under 11 mph (18 km/h) when the engine had been left ungoverned, and it would have therefore been possible to adjust the governing to give, for example, a maximum speed of 10 mph (16 km/h). However, this would have increased the cyclic wear of the engine and therefore lowered its mileage life, which at the current 1200 miles (1900 km) was already unimpressive. Overall, the proposition to produce a two-man turret for the A11 was "not considered worth doing", although the Vickers representatives had devised an alternative means to address Harold Brown's dilemma, as "Commander Micklem then said that they had considered these questions and that they would rather use a tank such as A.10 as the basis for an improved infantry tank." After further discussion, the DGMP submitted that:

> As regards an improved infantry tank, it was clear that the basis of this machine should be the A.10 tank. We would have to settle the minimum requirements. It was suggested that these should be armour on a 60 mm. basis and that the turret should take either one machine gun and a 15 mm. Z.B. gun or one machine gun and a 2-pdr. gun. As regards the 2-pdr. gun sufficient information had already been obtained to show that the W.D. pattern 2-pdr. gun and machine gun co-axial needed a considerably larger turret.

The "larger turret area" referred to here was in comparison to the space needed for the "15 mm. Z.B. gun", which was a 15 mm autocannon (the ZB vz.60) derived

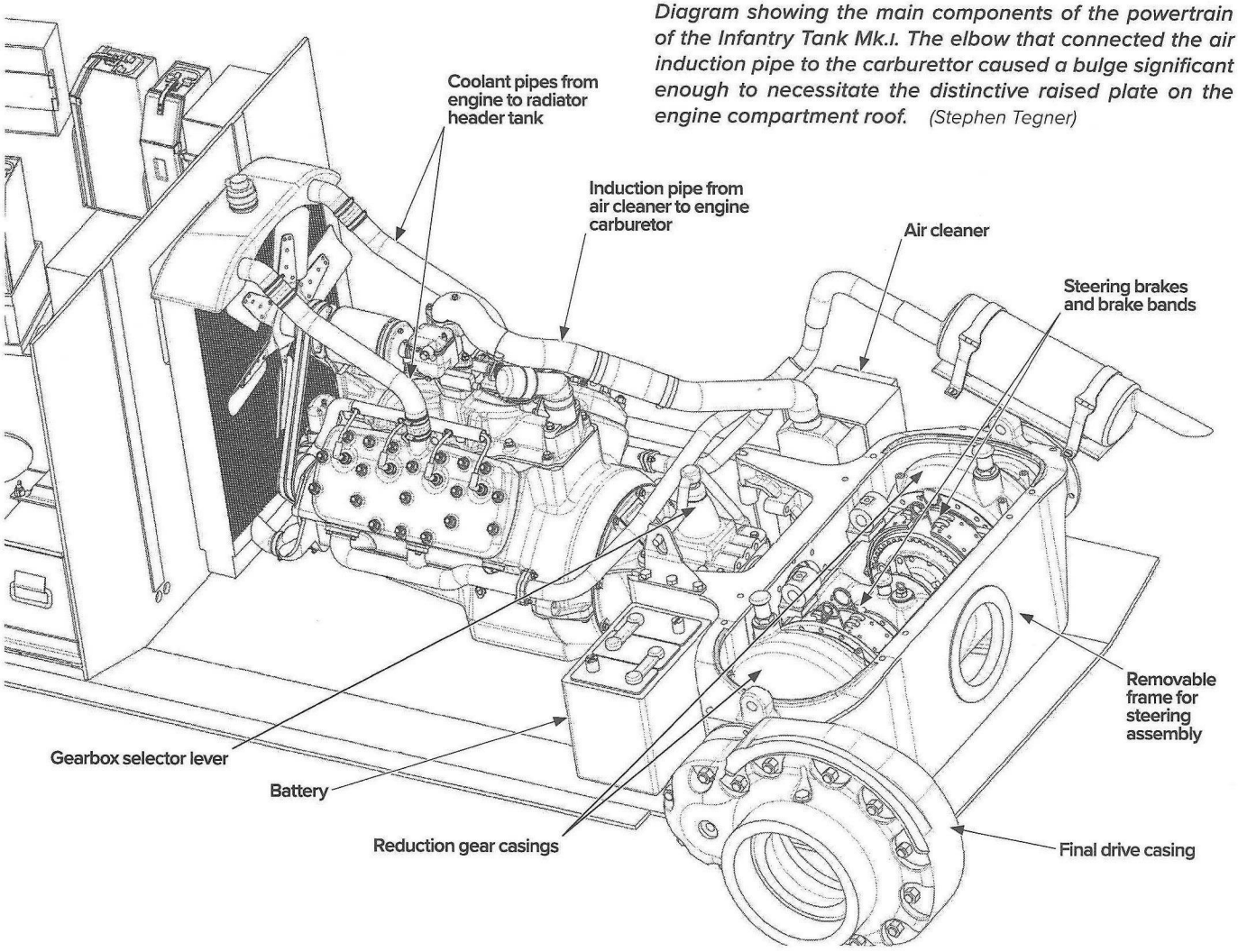

Coolant pipes from engine to radiator header tank
Induction pipe from air cleaner to engine carburetor
Air cleaner
Steering brakes and brake bands
Removable frame for steering assembly
Gearbox selector lever
Battery
Reduction gear casings
Final drive casing

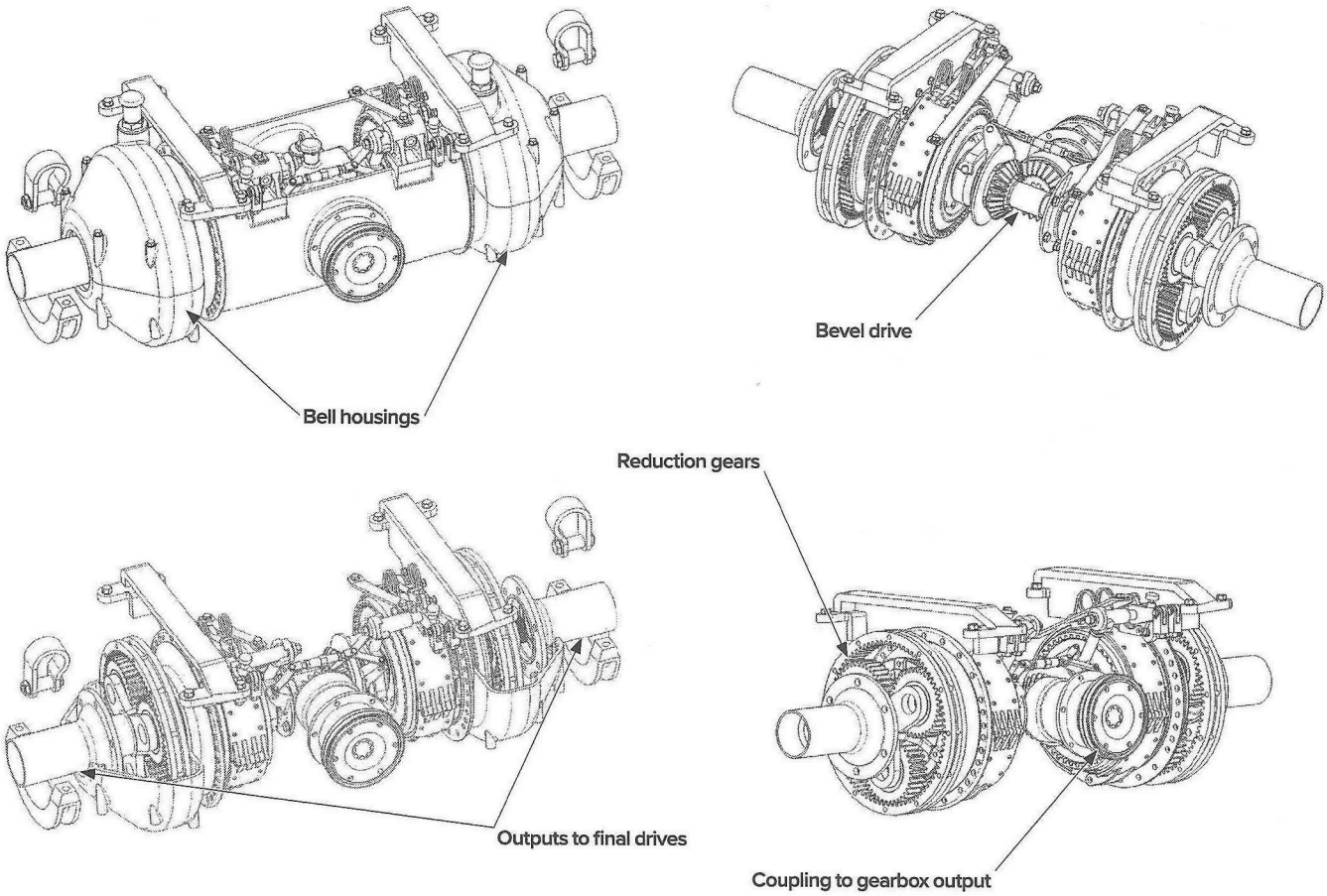
Diagram showing the main components of the powertrain of the Infantry Tank Mk.I. The elbow that connected the air induction pipe to the carburettor caused a bulge significant enough to necessitate the distinctive raised plate on the engine compartment roof. (Stephen Tegner)

from the ZB 53 7.92 mm machine gun that had already been discounted for the A11. Although the ZB vz. 60 did not approach the penetration of a 2 pounder weapon, it had the advantage of dispensing with the need for a loader, and thus obviated the need to provide space for a third man. This would be crucial, as reducing the size of the turret meant that the armour could be increased in thickness with the least effect on the overall mass of the vehicle. There was a further alternative to the War Department (*i.e.* service) 2 pounder, however, as "Mr. Little explained that Vicker's pattern tank gun with a machine gun co-axial could be set into the same turret that they would design for a machine gun and a heavy machine gun co-axial." This was a reference to the Vickers-Armstrongs 2 pounder tank gun, which had broadly similar performance to the service 2 pounder, the ability to fit in a smaller turret implying that it would be provided with an autoloader, which the War Office representatives consequently insisted on. The main drawback of this weapon was that it fired different ammunition to the service 2 pounder and so the meeting minutes documented that:

> It was then agreed that Vickers should investigate the design of a new infantry tank using A.10 tank as a basis and that the turret should either hold one machine gun and 15 mm. Z.B. gun or one machine gun and the Vickers pattern 2-pdr. tank gun. It was to be made clear that the Vickers pattern tank gun could not be accepted unless it could take our standard ammunition.

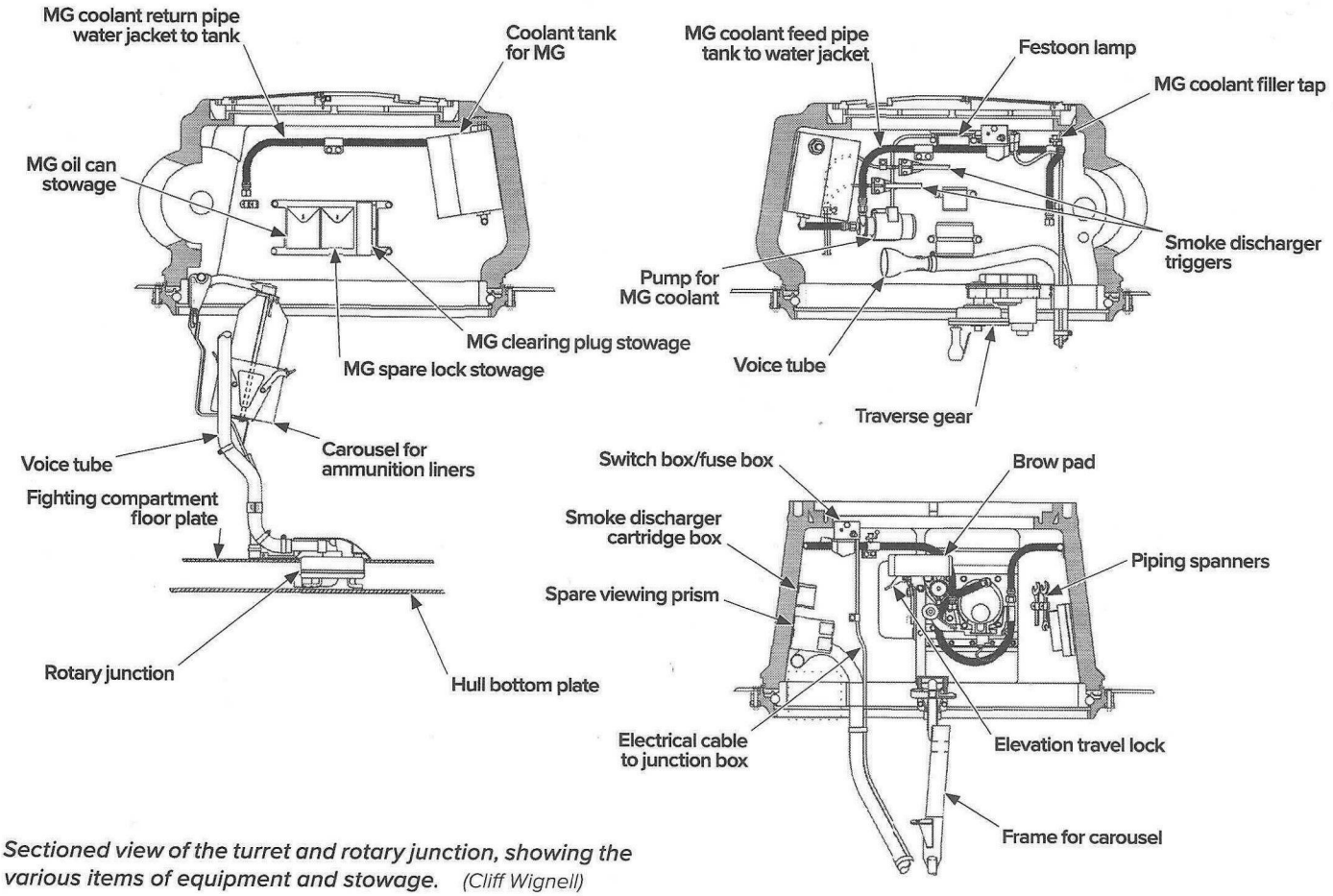
What went unmentioned was that even if the Vickers gun could be adapted to fire service ammunition, it would still have to surmount the formidable opposition of the new Director of Artillery, E.M.C. Clarke. Nevertheless, the wheel had turned full circle, as the A10 had been proposed as the first Infantry tank, and was now in contention to supersede the two designs that had been produced to overcome its perceived shortcomings, especially as regards armour thickness. A brief outline specification of the modified A10 was included in the minutes, this stipulating a top speed of 12 mph (19 km/h) on a level circuit, a range

Various views of the steering assembly. (Stephen Tegner)



of 50 miles (80 km), and the ability to cross an 8 ft. (2.4 m) gap, while the engine cooling would have to be sufficient for tropical conditions. It was decided that the prototype A10E1 at Farnborough would be returned to Vickers-Armstrongs at Chertsey on their request, in case it proved useful in configuring the new Infantry variant. Finally, the meeting minutes stated that "Admiral Brown said that the wanted a report from Vickers in a month's time on the subject of the general lay-out and design of this tank and if possible an estimate of the cost." This would mean that the firm would have to report to the DGMP around 14th February, which was Valentine's Day. MEE report A45/16 of 27th January 1938 detailed that the third pair of tracks fitted to A11E1 had now completed 995 miles (1600 km), of which 775 (1247 km) had been across country in mostly good conditions, and 220 (354 km) on road. Since the last report on these items at 682 miles (1098 km), only one track link and one pin had been damaged, during the wire obstacle trials, otherwise no problems had been experienced. The track links themselves had now elongated by 5.7% over their original pitch. Harold Brown's worries over progress on the A12 were demonstrated in a minute he submitted to Sir Frederick Bovenschen on 8th February, in which he explained that the order for 65 of these tanks was being "temporarily held up for settlement of certain design faults." Brown was also pressing for another order for fifty A9's, these counting as a portion of the requirement for 271 Cruiser tanks, in the same manner as the first fifty A9's, which had originally been ordered as Medium tanks.

The Vickers development facility at Chertsey managed to meet the deadline for the basic design of the A10-based Infantry tank, such that a meeting was arranged on 10th February, this once again being in Harold Brown's room at the War Office. This was attended by Maurice Taylor, Alexander Davidson, 'Q' Martel, and Joseph Hollebone, as well as the Director of Staff Duties (DSD), Ernest Squires, and the DDSD(AFV), Frederick Hotblack. The Vickers-Armstrongs party was led by none other than the firm's joint Chairman and Managing Director, Sir Charles Craven, with Robert Micklem and J.E. Richardson arriving from the Elswick Works and Leslie Little and Vivian Loyd representing Chertsey. Micklem commenced proceedings by explaining that in order to prove the viability of a 60 mm armour basis on an A10 chassis, the firm had loaded up A10E1 to 16 tons and run over 600 miles (1000 km). He further pronounced that "No trouble had



Sectioned view of the turret and rotary junction, showing the various items of equipment and stowage. *(Cliff Wignell)*

been experienced other than some tyre trouble which they considered could be overcome without difficulty." The new machine was tentatively referred to as the "Vickers Tank (Valentine)", and the Vickers representatives showed the War Office representatives a series of charts that showed the comparative attributes and performance of the Valentine against the A11 and A12. These were not received without qualms, the meeting minutes reprising that:

> The point was then raised that Messrs. Vickers had been asked to include a self loading mechanism for the 2 pdr. if there was no space for a loader in the turret. Their proposal however showed a two man turret without self loading device. This meant that the commander of the tank would have to act as loader. This point was discussed and D.S.D. stated that although it was unlikely that they could accept a turret without either a loader or a self loading device, they required time to consider the whole problem as Messrs. Vickers proposals were new to them.

The Vickers representatives nonetheless argued that the principle advantage of their new design was that the transmission and suspension components had already been tried and tested, so there was a lower risk of failure than with a new design. They did warn, however, that 16 tons was the limit that the drivetrain and suspension could bear, making it impossible for it to take a three-man turret on the same armour basis. As regards production, the firm submitted that production at the Scotswood Works could commence by March 1939. It was proposed that Vickers make a wooden mock-up of the Valentine for inspection by the War Office, with the War Office representatives requesting that the turret be mocked up first. They then stated that they would give instructions on 14th February as to whether the firm should proceed with this project. After the meeting 'Q' Martel suggested to the Vickers representatives that they submit a proposal for an alternative model of the Valentine with a three-man turret on a lighter armour basis, this being agreed by the firm. The Valentine project would not be issued with a dedicated 'A' number as it was to be initially developed under the A10 designation, and was not considered a private venture on the part of Vickers, as it had been designed in response to a direct request from Harold Brown. There was however a degree of unease within the War Office about the method of its sourcing, and John Crawford, who was at this time 'Q' Martel's deputy, would later

(on 2nd January 1959) inform Sir Bertram Rowcroft, the former Director of Mechanical Engineering, that "The story of the 'Valentine' Tank (so called because Vickers produced it on St. Valentine's Day), was accepted under duress, because Vickers refused to agree with the development of the 'Matilda'." In fact, Robert Micklem and Leslie Little had merely pointed out the impracticability of developing the A11, rather than having refused to countenance it, with Crawford not having personally attended the meeting concerned. The proposed three-man turreted version of the Valentine would be presented by Vickers to the War Office on 17th February, this incorporating a reduction in the armour basis to 50 mm.

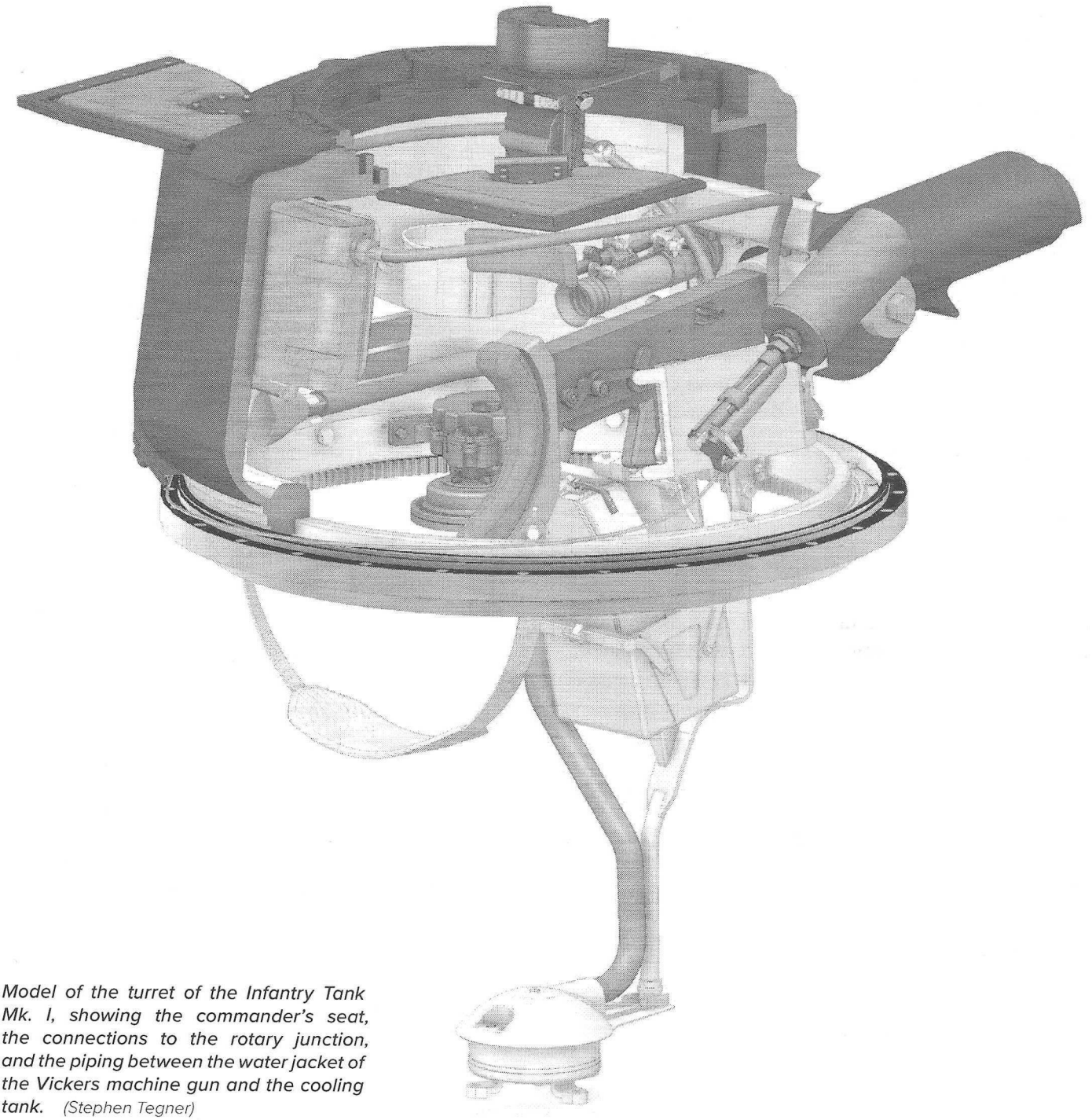
MEE report A45/17 was issued on 25th February on another set of cooling trials on A11E1 that had been undertaken four days previously. A total of seven runs were undertaken, during which the driver's hatch and the newly added sliding blanking plate on the engine compartment bulkhead remained open, although for the first four tests the blanking boards were fitted over the ventilation inlets behind the turret. Each run was over a two mile (3 km) circuit of firm ground in 3rd and 4th gears, the maximum engine cooling water TD being 146 °F (63 °C) with the blanking boards fitted and 130 °F (54 °C) with them removed. Similarly, the maximum engine oil TD was 184 °F (84 °C) with blanking boards fitted, and 168° F (76 °C) with them removed. These were notably higher than the results garnered the previous April. Accordingly, Mechanization Board Minute A2935 of 14th March recommended that the current Ford model 51-8005B radiator, which was sourced from the USA, be replaced by the newer British Ford model 79-8010A2 radiator, which had 204 tubes. This was to be trialled on A11E1 alongside another design of radiator by the Gallay Radiator Co. Ltd. of Willesden in London.

This minute also listed the issues that had afflicted A11E1 thus far, as well as the modifications made to overcome them, and mentioned a small number of alterations that had thus far not been logged by the MEE. These included the provision of a master bolt in the sprocket ring fixings in order to ensure correct alignment, and the splining of the distance sleeve between the clutch body and the bevel gear, the flange thickness of the sleeve also being increased to 0.5 in. (13 mm). The housing for the bevel drive assembly to the steering clutches was additionally keyed to prevent its mounting bracket from twisting. At a meeting at the Mechanization Board in Woolwich on 18th March, Joseph Hollebone informed the DDM(V), 'Q' Martel, and his Assistant Director of Mechanization (ADM), Colonel Douglas Pratt, that the new British-made Ford radiator had been installed in A11E1. Hollebone also informed the attendees that the first A12 prototype, A12E1, was now expected to commence running at the MEE by the 21st or 22nd March. On 21st March Vickers-Armstrongs were informed by 'Q' Martel that the General Staff had rejected their proposal for the Valentine with three-man turret, as their proposed 50 mm armour basis was deemed to be too thin. Nonetheless, on 24th March the wooden mock-up of the two-man variant of the turret was examined at Chertsey by Ernest Squires, Alexander Davidson, Frederick Hotblack, 'Q' Martel, Douglas Pratt, Justice Tilly and Albert Macrae, as well as Colonel John Holland of Hotblack's department, SD7. The minutes of the subsequent meeting noted that "The object of this turret was to bring down the weight, so that sufficient armour could be carried to make the Valentine edition of A.10 acceptable as an infantry tank." A Vickers 2 pounder had been fitted in the mock-up although Macrae pointed out that "the Service 2-pdr. could be equally incorporated." Nevertheless, the conclusion of the meeting was negative, as:

> It was decided that the small turret might be accepted in certain circumstances. It has however disadvantages such as lack of alternative vision for the Commander. Moreover, the armour proposed for the Valentine tank was still insufficient. This taken with other disadvantages, made it impossible to accept the Valentine proposal as an Infantry tank.

The 60 mm armour basis was presumably rejected on the grounds that the equivalent basis on the A12 was 70 mm, although it should be noted that 60 mm was more than sufficient to counter any current or planned anti-tank gun. It was however decided to examine whether it would be possible to convert the standard A10 from a Medium to a "Heavy Cruiser" tank by the provision of a hull machine gun, this having already been mocked-up by Vickers and examined alongside the Valentine. The fate of the Valentine, at least for the time being, would be sealed at a conference in Maurice Taylor's room in the War Office on 1st April, this being chaired by Harold Brown and attended by Taylor, Squires, Martel, Hotblack, Hollebone and Pratt, as well as the Vickers trio of Micklem, Loyd and Little. The DGMP began by stating whether the Valentine was really required, adding that "in comparison with A.11 it would be faster, have a 2 pdr. gun and a crew of 4." This was not fully correct, of course, as with the smaller turret it would only have a crew of three. Ernest Squires then interjected, the meeting minutes documenting that:

> D.S.D. stated that it was the considered General Staff opinion that A.10 (Valentine) Tank was definitely unsuitable as an I Tank. The General Staff considered a dilution of A.12 and A.11 would be the best solution. He agreed therefore that it would be far better to



Model of the turret of the Infantry Tank Mk. I, showing the commander's seat, the connections to the rotary junction, and the piping between the water jacket of the Vickers machine gun and the cooling tank. (Stephen Tegner)

order another batch of A.11 (Matilda) than accept A.10 (Valentine).

The minutes further recorded that "It was agreed to place an order for a further batch of 60 A.11 (Matilda) tanks", this bringing the total of A11's on order up to 120. This early rejection of the Valentine would be the second major reason for it not receiving a dedicated 'A' number, as no active development project had been stimulated by Vickers' proposal. Harold Brown minuted the CIGS, Lord Gort, on 6th April to seek his approval for the 60 additional A11's, which unlike the first batch of 60 would be manufactured at Scotswood. Once Gort's blessing had been received, the DGMP estimated that their production could be commenced in January 1939 and completed by November that year. Gort would give his assent a week later on 13th April, this date also witnessing the publication of Mechanization Board Minute A2946, which revealed that the service designation of the A11 would be Tank, Infantry, Mark I. This minute also suggested that the first batch of

60 A11's had already entered production at Elswick, although no prior official confirmation had been given. The British Ford radiator fitted to A11E1 had not lasted long, being quickly substituted with the alternative Gallay radiator, this being the subject of MEE report A45/18 of 25th April. A pair of runs had been conducted over a two mile circuit at Farnborough on 12th April, the first with the tank completely closed down, and the second with the blanking boards for the engine compartment inlet louvres removed. Remarkably for both runs, the water and oil temperature differences were virtually the same, being 147°F (64°C) for the first run and 146°F (63°C) for the second, the removal of the blanking boards making little difference while the commander's and driver's hatches were closed. These compared favourably with the figures obtained during the previous cooling tests as delineated in report A45/17, especially with regard to the lubricating oil figures. The cooling trial was suspended after these two runs due to the degraded performance of the engine, the report mentioning that:

> A subsequent examination of the ignition and carburation systems failed to disclose the cause of this erratic running, or the high temperature recorded, with the possible exception of the fact that the Gallay radiator, being deeper than the Ford, causes a slight restriction to the air intakes in the side of the vehicle.

The "air intakes in the side of the vehicle" alluded to here were the ventilation inlet louvres, which were on top of the hull, although there was one inlet on each side. On a more general issue, it had been observed that the removal of the engine in A11E1 could not be facilitated without the prior removal of the radiator. This was due to the bolts that secured the feet of the radiator to their support brackets, these being orientated upside-down so that the retaining nut could be accessed from above. It had been found that both the bolt head had to be held still in order to allow the nut to be unscrewed, and so a temporary fix had been devised in which a small rectangular steel plate had been welded to the bolt head, this abutting the support bracket and preventing the bolt from turning. MEE report A45/19, of 27th April, further recommended the substitution of the bolt with a stud for production machines.

War Office Memorandum No. 343 was issued on 2nd May, this at last setting out the anticipated reductions resulting from the shelving of the Continental commitment. The primary revisions were to the number of Army Tank battalions in the Field Force, which had been reduced from four to three, with an extra Cruiser battalion being proposed in lieu, this to be stationed in Egypt. The level of reserves had been reduced to 100%, as had been requested by Ernest Squires during the meeting on 23rd December 1937, although as an insurance, it was decided that a stock of major components would be held during peacetime in order to facilitate any acceleration in production on the outbreak of war, with £1½ million being allocated for this purpose. The change in emphasis from the Continental commitment to the Middle East had prompted a rebalancing between Infantry and Cruiser tanks, as the relatively static conditions anticipated in a European war gave way to the expected fluidity of war in the desert. Along with the omission of war wastage, this had resulted in a reduced requirement for Infantry tanks from 833 to 340, which was less than the 548 that had already received Treasury sanction. This was a drastic cut considering that the proposed number of Army Tank battalions had only been reduced from four to three, and indicated that a large portion of the original allocation of Infantry tanks was in fact being sought for the reservist Territorial Army (TA). The requirement for Cruiser tanks, disregarding war wastage, had correspondingly increased, from 435 to 585, this reflecting the reformulation of the battalions of the Tank Brigade to be composed only of Cruisers, and the proposal to provide a Cruiser regiment for the Middle East. However, if the original reserve requirement was included, then this figure actually represented a small reduction, from 350 Cruisers and 247 Mediums (*i.e.* 597 tanks in total). The provision of Light tanks had been revised slightly upwards to 1331, this figure including 81 Light tanks that had been produced prior to the publication of War Office Memorandum No. 9 in May 1936. The increase was due to the number of Cavalry regiments requiring Light tanks having risen to 12, albeit with a reduced unit requirement, and the Royal Horse Artillery requiring a small number of Light tanks for use as Armoured Observation Posts. The number of carriers of the various types in the AFV programme had been substantially increased to 2140, while the number of armoured cars had been modestly incremented from the 154 set out in Memorandum No. 9 to 168, in order to provide additional reserves for the armoured car regiment (11th Hussars) in Egypt.

Altogether, the total cost of the AFV's required amounted to £19¾ million, this representing a value £4½ million above what had already been approved by the Treasury, although the number of Light tanks (1046) and carriers (1672) already sanctioned had risen from the figures previously quoted by Sir Frederick Phillips (891 and 1617 respectively) on 16th October 1937. This total was further augmented by the requirement for war reserve stocks (£1½ million as previously noted), and various spares and ancillary equipment, such that the revised programme total came to £22⅔ million. This represented a saving of over £7 million from the previous programme estimate of £29¾ million (*i.e.* the combined £12 million of Memorandum No. 9 and £17¾ million of Memorandum No. 95). It also represented

more than half of the £14 million saving across the entire Army rearmament programme that Hore-Belisha had anticipated from his New Army Policy when he had introduced it back in January. It was pointed out that "This memorandum relates only to the requirements of the Regular Army and does not include those of the Territorial Army", this comment revealing that most of the savings accrued from the reduction in the number of Infantry tanks had been achieved by the removal of the hypothetical future TA requirement. Lyon presented Memorandum No. 343 to the 140th Meeting of the TISC on 4th May, with Edward Bridges, on behalf of the Treasury, asking for an assurance that the requirements laid out in the memorandum were fixed. Ernest Squires responded by stating that "broadly this assurance could be given", as the organisational requirements were now settled. As far as the vehicles themselves were concerned, the committee were informed that:

> Orders had now been placed for 165 of cruiser and medium tanks. It was proposed to await results before further orders for these types were placed, in case it was necessary to introduce modifications. As regards 'I' tanks, the design was now settled and the War Office was ready to place orders for production in quantity.

Squires mentioned that the revised calculation of requirements was "based on the most favourable assumption as to the readiness of manufacturers to enter production on a war basis", as:

> Even on such an assumption, production would take nine months from zero to catch up with war wastage. The war reserve on a 100 per cent scale, though sufficient to meet wastage in the first few months of war, would not bridge the gap between war wastage and war production, unless measures were taken in peace to accelerate war production.

The "measures taken in peace" referred to here was the proposal to hold a reserve stock of major components, the DSD pointing out that this had an advantage over holding completed vehicles in that it tended to mitigate against obsolescence. This in turn was because the stored components (such as engines, gearboxes, suspension units etc.) might still be compatible with later designs of AFV. Kenneth Lyon explained that the War Office was not seeking Treasury authority for the revised programme with the intention of placing immediate orders to make up the balance of the programme, but rather so that manufacturers could be warned that orders were in prospect, thus enabling them to plan production accordingly. He further underlined that it was not possible for manufacturers to accelerate the completion of existing orders unless continuation orders were in prospect. Squires expressed his hope that orders for the balance of requirements, to meet the full progamme, would be placed in time for deliveries to units to be completed before the summer of 1940, and after deliberation, the TISC approved the programme at £22⅔ million. The first 65 production A12's would be ordered from the Vulcan Foundry on 9th May, under their service designation of Infantry Tank Mk. II, while the second batch of 60 Infantry Tank Mk. I's (A11) would be ordered from Vickers the following day, 10th May, under contract T5429. A meeting was held on the general tank situation in Harold Brown's room in the War Office on 16th May, this being attended by Lord Gort, Maurice Taylor, Ernest Squires, Alexander Davidson, and 'Q' Martel, as well as by Brown himself. With regard to Infantry tanks, the meeting minutes proclaimed that:

> It was agreed that, subject to the correction of certain detailed defects, all future orders should be for A.12 tanks, and D.G.M.P. agreed to make the necessary arrangements. The question of building all the reserve A.12 tanks was raised. C.I.G.S. agreed that it would not matter if the reserve tanks were not completed till the end of 1940, but they did not want to reduce the numbers. If possible they would like later to be able to equip all regular 'I' Battalions with A.12 tanks and use A.11 tanks for the T.A.

As 340 Infantry tanks were being sought, and as 120 of these had already been ordered as A11's, this meant that there were 220 Infantry Tank Mk. II's required, with the three Army Tank Battalions currently requiring 75 each as unit equipment, or 225 in total. This left a reserve of 115 to be completed by the end of 1940, the minutes disclosing that "On this basis it was agreed to order a further 65 A.12 Tanks from Messrs. Vulcan (*i.e.* 130 in all) for completion by August 1940." As a further 90 A12's would be needed to complete the reserves, it was also propounded "to arrange if possible that the Railways should make jigs &c., for A.12 and be given orders for any production they could undertake — the balance to be placed with another firm to be agreed with Vulcan." The proposal to prioritise Infantry Tank Mk. II's for RTC Army tank battalions meant that the Infantry Tank Mk. I's would be siphoned off to the Territorial Army as the "reserve" A12's were delivered. The rather leisurely approach to building Infantry tanks exhibited here merely reflected the fact that Hore-Belisha's New Army Policy had prompted a (wholly artificial) emphasis on the sourcing of Cruiser tanks. These had in fact been the main focus of this meeting, which had itself been precipitated by a meeting at

A11E1 with Fowler mine plough, showing the coulter blades and rollers at the front of the frame working through long rank grass. This photograph appears to have been taken either in the early morning or late evening, hence the dark shadows from the low sun. *(National Archives)*

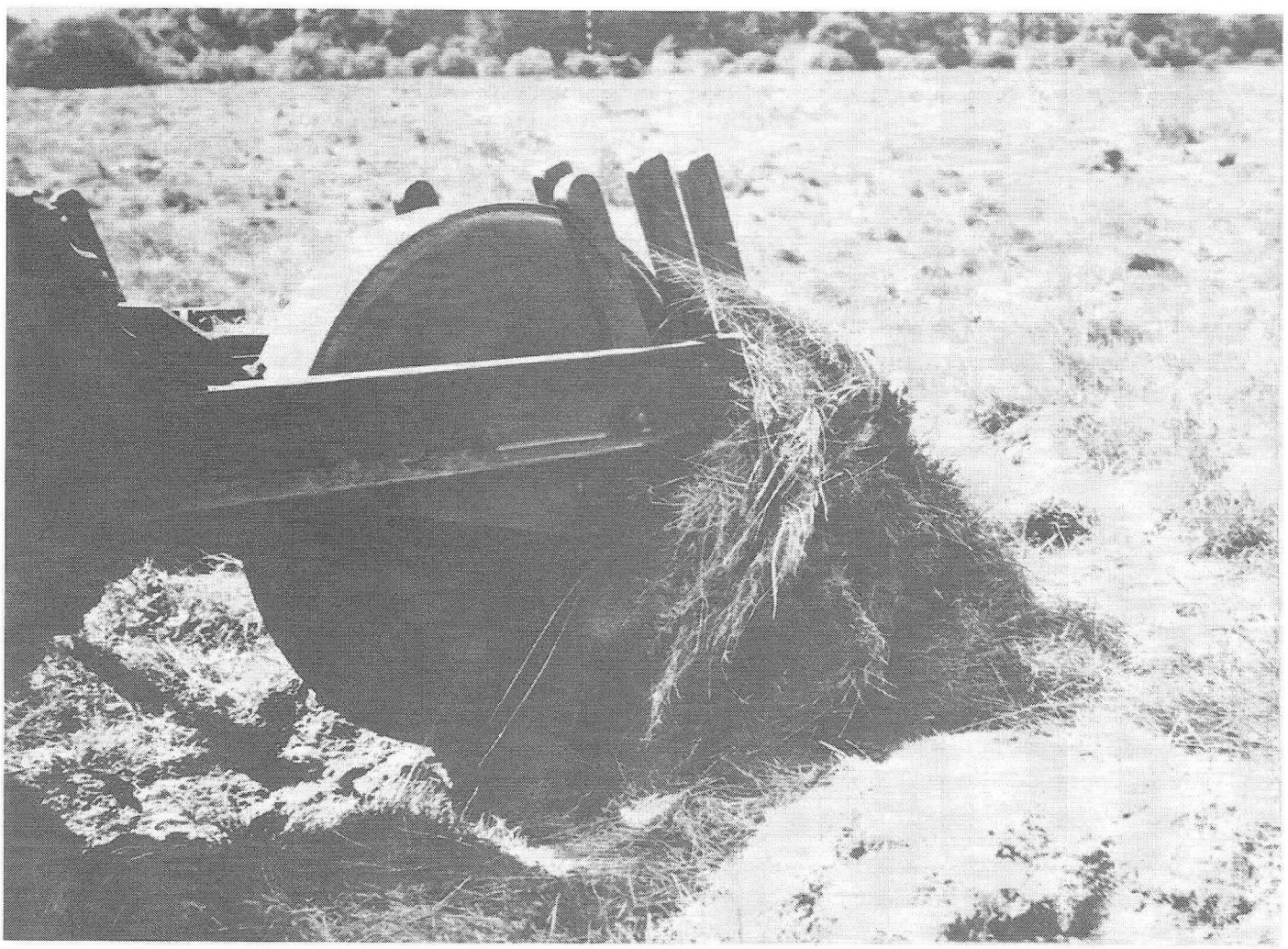
Caxton house in Westminster on the 6th May, in which the General Staff had recognised a need for "Heavy Cruisers" as well as standard Cruisers, such that they wanted to retain sufficient funding for a considerable number of A16's. The General Staff now submitted that the revised requirement for 585 Cruisers should be split between 268 "light" Cruisers and 317 Heavy Cruisers, with the "light" Cruiser requirement being composed entirely of A13's, this necessitating the reclassification of both the A9 and A10 as Heavy Cruisers. As a consequence, the General Staff members (Gort, Taylor, Squires) attending the current meeting proposed that the existing order for 100 A9's should not be increased for the present time, while the order for A10's should be increased to 100. This would leave 117 Heavy Cruisers, which were to be produced as A16's if possible, while "Of the total 268 light cruisers, 65 A.13 tanks were on order and they realised that it was undesirable to order any more at present." This hesitation was due to the many technical problems that were being encountered on the latest A13 prototype, A13E2, and the uncertainty had brought into contention a design from Vickers-Armstrongs, which had been dubbed the PR Tank by the firm and the Purdah by the War Office. Although only conceived as a six ton Light tank with a three man crew, its comparatively heavy armament of a Vickers 2 pounder gun and co-axial 0.303-in. Vickers machine gun rendered the possibility of it serving as a makeshift Light Cruiser. This machine, which would be officially designated as the A17, also boasted a potential road speed of up to 40 mph although it did, however, suffer the disadvantages of a two-man turret and an armour basis of only 14 mm. Following the meeting, an order for the second batch of A12's would be submitted to the Vulcan Foundry on 11th June, this coming under the same contract (T5115) as the first batch.

A11E1 had been selected for trials of an anti-mine plough that had been designed and manufactured by the agricultural engineers John Fowler & Co. Ltd. of Leeds. This consisted of a pair of heavy steel rollers mounted in a steel frame that projected forward of the vehicle, with each roller being chaperoned by an array of five coulters, a coulter being a vertical blade that on a normal plough breaks up the earth ahead of the

ploughshare. The rollers were located directly in front of each track, their purpose being to support the frame for the coulters, these latter breaking up the earth to a nominated depth of a few inches (ca. 5 – 10 cm), thereby uncovering and harmlessly displacing any mines they contacted. As the plough only cleared a path ahead of each track, it was only intended to permit the passage of the vehicle that mounted it, and so was not a general mine-sweeping device for clearing "lanes" for subsequent vehicles or personnel to pass through. The first iteration of the mine plough, weighing 1¼ tons, had been delivered to the MEE by Fowlers on 21st May, this having been fitted by the firm's personnel to a Dragon Mk. IIIC artillery tractor, T1336, for initial trials. These revealed that the optimum depth of the coulter blades was about 2½ in. to 3 in. (6 – 8 cm), and the optimum speed of operation was 3 mph (6 km/h). A "sacrificial" version of the device had also been tested on T1336, in which the coulters were removed and two rollers provided on each side, one roller directly in front of the other, the rollers themselves being expected to detonate the mines on contact. This was found to protect the vehicle, although the effect of the shards resulting from the destruction of the rollers was considered to be potentially dangerous to any crew members. A second mine plough had been designed for fitting to A11E1, this being provided with a gearbox and power take-off for raising and lowering, unlike the original plough which was winched up and down by hand. This was fitted to the vehicle by the MEE workshops under the supervision of the firm, the work undertaken being detailed in MEE report A64/2 of 27th May.

The frame for the anti-mine plough was mounted on A11E1 by a pair of side arms that were attached to pivots on each side of the hull. The power take-off was taken from the gearbox, the offside engine cover plate having to be locally cut away in order to clear the coupling between them. This powered an external gearbox (or "winch gear"), which in turn drove a cross shaft with a pulley at each end. These pulleys were connected to the side arms of the plough frame by chains,

This photograph demonstrates how the coulters tended to get choked by the long grass, this not impairing their ability to dislodge mines, although it was thought that pushing the grass forwards might cause active mines to detonate. *(National Archives)*



thereby facilitating the raising of the plough for normal travel, or its lowering for mine clearing, via the pivots. The rear engine deck on A11E1 featured a centrally mounted exhaust pipe with silencer, either side of which was a hatch door for accessing the steering clutches and reduction gears. The offside of these doors, along with rear roof plate on which it was mounted, had to be cut away in order to clear the drive from the power take-off to the winch, the door being fitted with a cowl to cover the resulting aperture. The exhaust was relocated onto the nearside door to avoid fouling the winch housing. A11E1 was fitted with number plates with a vehicle registration mark (VRM) for road use, and the rear number plate had to be temporarily moved from the offside rear engine deck to the top of the winch housing (or "winch box"), as its original position had been obscured by the cross shaft from the gearbox. The flimsy body of the winch box did not escape criticism, as:

> The front and rear cover plates of the winch box are made of sheet metal which warps around the edges and allows oil to escape. It is suggested that a strengthening rim around the bolt holes be incorporated. This has been done on the rear plate.

The engagement of the selector gear for the power take-off by the driver was via Bowden cables, it being remarked that "These were found to be insufficiently strong to operate the winch and have been replaced by tubular section push and pull rods." At the front end of the tank, the tool boxes located on each side of the hull just behind the idler wheels had to be removed in order to fit the forward supports for the vertical guide plates for the plough. These plates were thin vertical strips that were located on the outside of the tracks to keep the frame laterally stable, and were connected to the forward hull by an upper and lower horizontal tube. It was commented that "By redesigning the boxes it would be possible to have them in approximately the same position, their capacity, however, would be reduced", this effectively meaning that the tool boxes would have to be reduced in length. The track adjusting lever, which was a hand tool for engaging the lug on the cranked axle of the idler wheel, was carried externally on a pair of brackets on the nearside hull, the forward mounting bracket for it being discovered to foul the plough frame when it was elevated. It was therefore decided to move the lever and its mountings approximately 18 in. (50 cm) rearwards, while the "hand" end (as opposed to the socket end) of the lever was also partially flattened for a length of 1 ft. (30 cm) in order to clear the plough frame. The first mine trials were recounted in MEE report A64/3 of 27th June, these being carried out with dummy mines that were weighted to 8 lbs. (3.6 kg), with A11E1 proceeding at a maximum 3 mph (5 km/h). Three types of ground conditions were evaluated, these being sandy terrain, short grass, and long rank grass, which was grass that was thick, matted and liable to form tussocks. For both the sandy terrain and short grass, it was found that "The great majority of mines are uprooted and deposited clear of the track-way." In the long rank grass the coulter blades tended to become choked, although even in this condition they dislodged the mines and deposited them away from the track path. However, it was speculated that the choking of the coulters might cause active mines to detonate, while raising the blades to avoid them choking would be likely to leave portions of the ground unswept. There were two other scenarios by which mines might fail to be adequately cleared, of which the first was that:

> By being planted in accidents of the ground where they are missed by the blades but run over by the track. As minefields, however, would probably be laid in the dark along a taped line, it is unlikely that mines would be deliberately laid in such places.

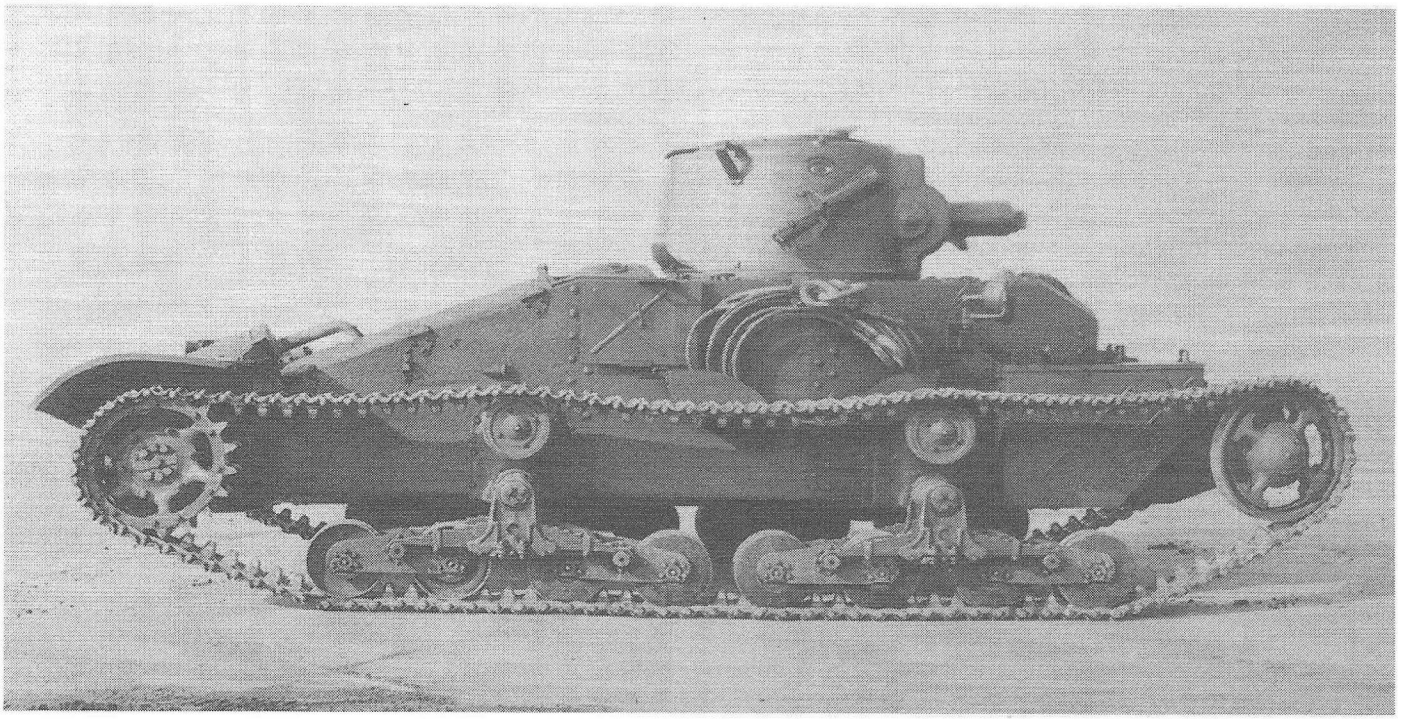
The term "accidents of the ground" referred in this instance to folds or dips in the soil, which would not be affected by the coulters but would likely be flattened by the tracks, thus ensuring the detonation of the mine. The second means by which the plough might be defeated was that "Occasionally a mine, on being dislodged, is turned sideways, passes beneath the blades and falls in the track path." The report nonetheless conceded that "This condition is very rare, but must be accepted." On the whole the results from this trial replicated those with the original mine plough as fitted to the Dragon Mk. IIIC, it being concluded that "A considerable degree of immunity from destruction from mines is conferred on the vehicle fitted with this device". It was however recognised that "Mines, when dislodged, are deposited within 2" [5 cm] of the track path" and so "Thus, to avoid them, extremely accurate driving on the part of succeeding vehicles when using the swept path is necessary." Although the performance of the plough was generally satisfactory, the Assistant Director of Mechanisation, Douglas Pratt, expressed concern as to the ease of detaching it from the vehicle. A subsequent trial revealed that it took a team of eight men 20 minutes to remove the plough, and as this was considered to be impracticable in the field, Pratt asked the MEE to submit modifications that effected an improvement. These would consist of four alterations to the side arm assemblies and their supports. The first of these would be to the pivot pins that formed the axis by which the plough was raised and lowered, and which were located at the rear end of each side arm. These were now proposed to be drilled radially at intervals so that they could receive a tommy bar

to aid their extraction from their mountings on the vehicle hull side plates. A pair of vertical struts were also located on the pivot at the rear of each side arm, either side of the track, with the inner strut having its top end connected to the pulley chain via a link member. It was now proposed that the joint between the strut and the link member become pivoted by means of a connecting pin for easier disconnection. The rear end of each side arm was also to be fitted with a "prop stand" that would fold downwards and support the plough after it had been disconnected. Finally, it was suggested that the vertical guide plates for stabilising the frame be modified to aid their disassembly. It was therefore proposed that the connection between their mounting tubes and the hull be by "bedstead" (*i.e.* socket) joints, the joints themselves being a permanent fitting on the hull.

The modifications were duly approved by the MEE and embedded on A11E1 for trials, it being found that two men could now remove the plough in three minutes, with the driver remaining in the vehicle. A drill was accordingly evolved in which the plough was held in the raised position while the guide plates and their connecting tubes were removed. The plough was subsequently lowered with the prop stands rotated into the supporting positions, and the winch chains disconnected from their pulleys. The pivot pins were then withdrawn sufficiently to allow the inner vertical struts to be swung into a horizontal position, and the pins were fully removed so that the tank could be reversed free of the plough. Representatives of John Fowler & Co. Ltd. were invited to view the modifications, and the firm were formally requested on 1st July to incorporate the changes into their design. Edward Crown of Fowlers would respond somewhat hesitantly on 4th July, stating that "we have carefully considered the proposals put forward but find there is a certain amount of difficulty in carrying them out." He therefore undertook to submit further details once the company had conducted further investigations.

A11E1 had also continued to be employed on cooling trials during this period, with a modified version of the Gallay radiator being fitted, this being subjected to an abortive run on 14th June, which was discontinued due to petrol starvation to the engine. This would have been due to the evaporation of the petrol in the fuel pipes to the engine, thereby causing a loss of pressure in the fuel system, the likely cause being the relatively high ambient temperatures in which the tests were conducted. The following day a gravity feed petrol tank was fitted to overcome this issue, this being the temporary installation of a single petrol tank in a higher position than the two existing petrol tanks. According to MEE report A45/20 of 30th June, the revised arrangement generated a maximum cooling water TD that exceeded 157 °F (69 °C) during two runs, the maximum lubricating oil TD being 157°F (69°C) exactly. These figures suggested that whatever modifications had been carried out to the Gallay radiator had had a deleterious effect. This radiator was then swapped with a Ford equivalent, which was presumably the British-manufactured 79-8010A2 model. A subsequent series of four two-mile (3 km) runs conducted on 17th June had generated a maximum water TD of 145 °F (63 °C), and maximum oil TD of 132 °F (56 °C), this marking an improvement over the unmodified Gallay radiator. Report A45/20 did not detail the trim of A11E1 during these trials, although it is most likely that the severest conditions were employed, *i.e.* the driver's and commander's hatches were closed down and blanking boards were fitted. The subsequent MEE report A45/21, also of 30th June, related that the Gallay radiator had been refitted, the opportunity also being taken to strip and clean the oil cleaner and engine air cleaner, and open the exhaust silencer for examination. A further cooling trial was attempted on 20th June, although during the course of a second run, the engine dynamo seized and the trial had to be abandoned. A new dynamo and fan belts were subsequently installed and the trial recommenced the following day, with five runs being completed. These generated a maximum water TD of 144 °F (62 °C) and maximum oil TD of 142 °F (61 °C), the test being marred by the radiator boiling during the third run. The two following runs were therefore conducted with the driver's hatch open, although this made little difference to the effectiveness of the cooling as on the final run the radiator boiled again.

The next series of cooling trials would commence on 13th July, after A11E1 had been fitted with a new Gallay radiator of "stepped" design, in which the horizontal tubes were grouped in steps rather than as a flat face. Three two-mile (3 km) runs were undertaken, the first of these with the engine governed down to produce a maximum speed of 4 mph (6 m/h), and the latter two runs with the engine being governed to an undefined faster speed. These latter runs were also marked by the driver engaging the lower gears in order to increase the engine revolutions and thus increase the speed of the cooling fan. The first run produced a maximum cooling water TD of 142 °F (61°C) and a maximum lubricating oil TD of 120°F (49°C), while the third run produced a maximum water TD of 136°F (58°C) and a top lubricating oil TD of 134°F (57°C). This run was also characterised by an engine stoppage due to petrol starvation, which was now a common fault during these trials, and a consequent switch to the gravity feed tank. Although these cooling figures were an improvement over those garnered in recent trials, they were still deemed unsatisfactory, and so the Vicker-Armstrongs representatives who had witnessed the trial confirmed that they would be supplying a new design of cooling fan. A new engine governor



Offside view of T3439, showing the production design of idler wheel, and the raised position of the sprockets, which was achieved by rotating the final drive casings rearwards. *(National Archives)*

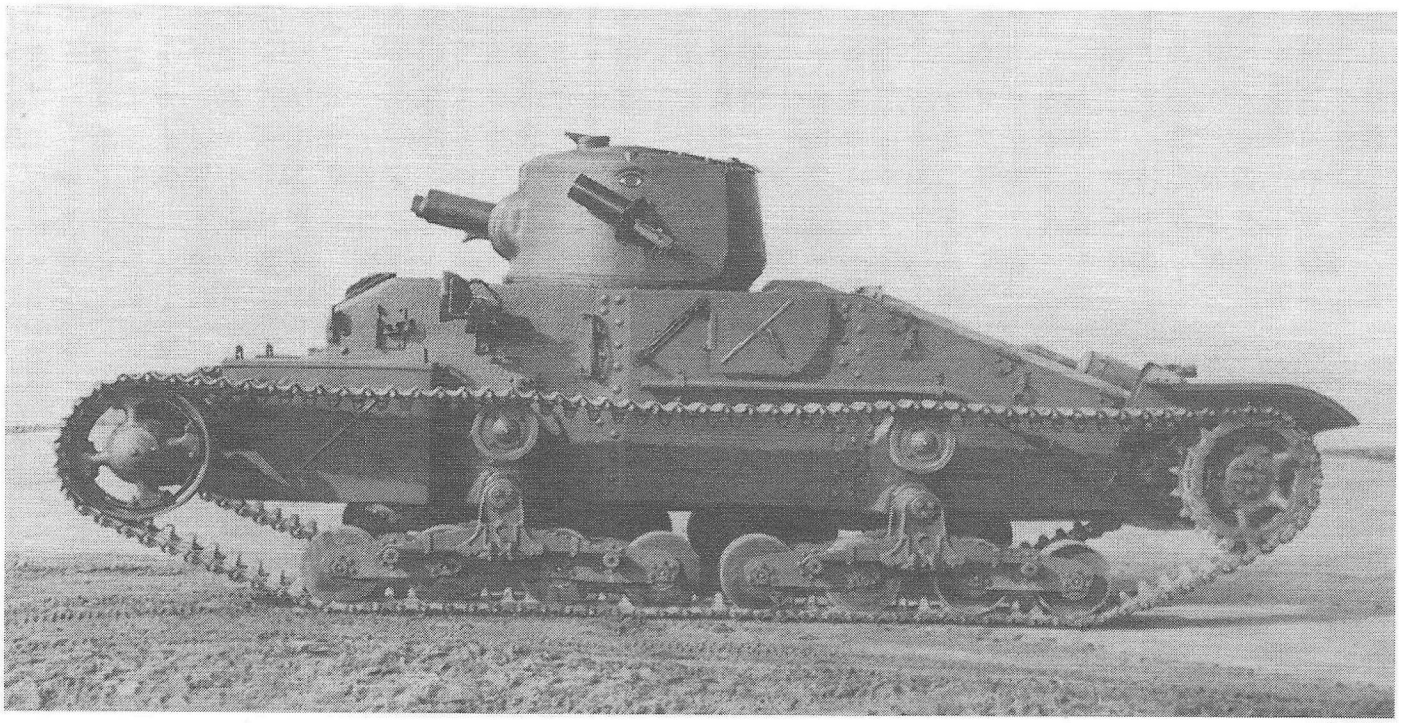
was fitted to A11E1 on 18th July under the direction of a representative of the Zenith Carburettor Co. Ltd., this being located between the carburettor and the engine inlet manifold. The installation of this governor would have necessitated the removal of the Solex carburettor and the refitting of the original Zenith device, which was also the production standard. The Zenith representative adjusted the new governor to give a maximum speed of 5½ mph (9 km/h), and then sealed the assembly prior to the next series of cooling trials. A total of five two-mile (3 km) runs were subsequently conducted on the same date, these generating a maximum water TD of 152 °F (67 °C), and maximum lubricating oil TD of 143 °F (62 °C), with the fuel supply being switched to the gravity tank after the second run due to the familiar petrol starvation.

Mine trials had also been resumed during July, after minor modifications had been undertaken to bring the side arms for the coulter plough level with the ground. A series of initial tests were conducted to assess whether an adjustment of the depth of the coulter blades could obviate the tendency of the plough to choke in long grass. As such, the leading blade was set to a depth of 2½ in. (6.5 cm) and the other four blades to a depth of 3 in. (7.5 cm), this however leading to severe choking to the point where the vehicle was actually halted, with the buried coulters acting as a fulcrum to lift it upwards. The leading blade was therefore set to a reduced depth of 1½ in. (4 cm) and the remaining blades to 2 in. (5 cm), this eliminating the choking but having the effect of occasionally raising the coulters clear of the ground. An intermediate setting was therefore chosen, with all five blades being positioned at a depth of 2 in. (5 cm), MEE report A64/4 of 29th July imparting that "This setting afford the best compromise from the point of view of freedom from choking and remaining imbedded in the soil." This setting was tested in the usual three types of terrain, it being confirmed that on sandy soil "The great majority of mines are uprooted and deposited clear of the trackways." The performance of the coulters in short grass was slightly more awkward, as:

> The majority of mines are uprooted and deposited clear of the trackways. In this type of terrain the coulters on occasions, owing to accidents of the ground, nose dive and choke, but clear themselves after a short period of running. Even when partially choked they are effective in uprooting mines.

The report additionally observed that "It is always possible when the driver sees that his coulters are digging too deeply, for him to raise them, move his vehicle forward a yard [metre] and then drop them again." Once again, it was the long rank grass that proved the most difficult to negotiate, as:

> The coulters choke badly and a broad furrow is ploughed. Whilst choked the machine can still proceed at a reduced speed but there is no self cleaning action. In the choked condition whilst the



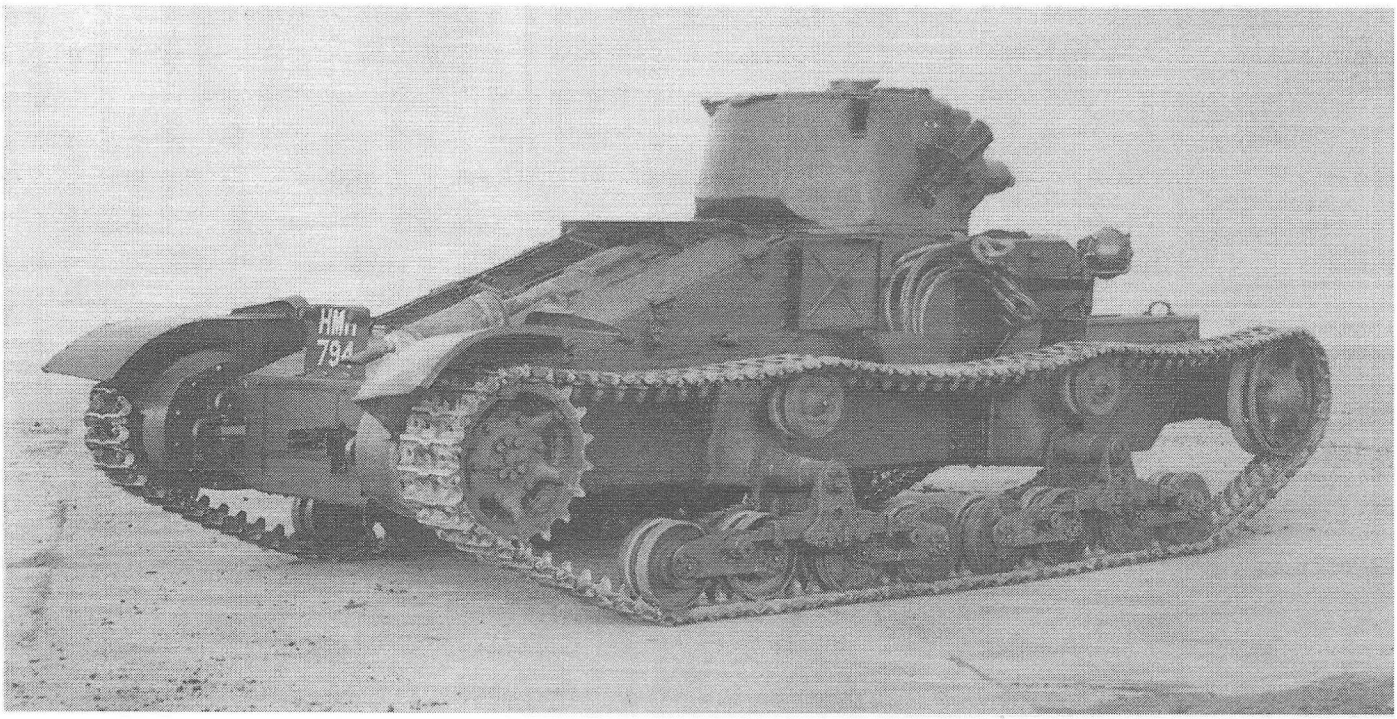
Nearside view of T3439, showing how the prominent front brow of the turret has been reduced by the increase in armour thickness from 60 mm to 65 mm. The vehicle has yet to receive the boltholes for the guide plate supports of the Fowler mine plough assembly. (National Archives)

majority of mines are uprooted and deposited clear of the trackways, a certain number will undoubtedly detonate by the coulter.

The conclusions also echoed the previous mine trial report (A64/3), in that it was foreseen that mines could evade the plough due to being buried in "accidents of the ground", by turning on their edges and passing through the coulter blades, or by being detonated by the tip of coulter blade during choking. It was also posited that evasion could occur due to mines rolling back into the furrow between the coulters and the tracks after displacement, presumably because they had been displaced onto uneven ground. Regarding the modifications to the plough in order to render it easier to remove, on 3rd August Edward Crown of Fowlers once again wrote to the MEE, expressing the firm's reservations about the MEE's scheme, as "we are sure you would have difficulty under certain conditions in withdrawing the hinge pins." Crown had therefore included a drawing of the firm's own further modification, this consisting of a change to the bearings in the vertical struts which enclosed the pivot pins, which would be changed to an "open jaw" type to allow the tank to withdraw from the plough frame with the pivot pins remaining in situ. This was discussed during a meeting at the MEE on 9th August chaired by Douglas Pratt and attended by Captain Richard Smallwood of MGO5, Captain R.G. Shaw of the Mechanization Board, Captain Howard Dashwood-Caple of the Chief Inspector of Armaments (CIA), and Major F.K. Couper and Lieutenant J.D. Kennedy of the MEE. Also present were Edward Crown of Fowlers and Vivian Loyd and C.O. Woodward of Vickers-Armstrongs, with Crown undertaking to supply parts for the firm's further modification of the pivot pin assembly within a week. These were to be fitted to the first production Infantry Tank Mk. I, T3433, in time for the next series of mine trials. Otherwise, the principle purpose of the meeting was to discuss the modifications that would need to be made to production tanks in order to fit the mine plough, as this was now envisaged as being a standard service equipment. It was accordingly pointed out that:

> The main difference between production and pilot models of the tank is that the track centres are about one inch [2.5 cm] further away from the hull on production models. Messrs. Fowler noted this fact for their production, but if it is required to fit the pilot model implement to the production model tank as a temporary measure, 1" [2.5 cm] packing pieces can be inserted on each side.

Another change on production models would be the relocation of the exhaust to the offside of the engine deck, and the provision of a single roof hatch for accessing the steering gear, this replacing the pair of doors employed on A11E1. On T3433 this hatch would need to be modified with an aperture for the



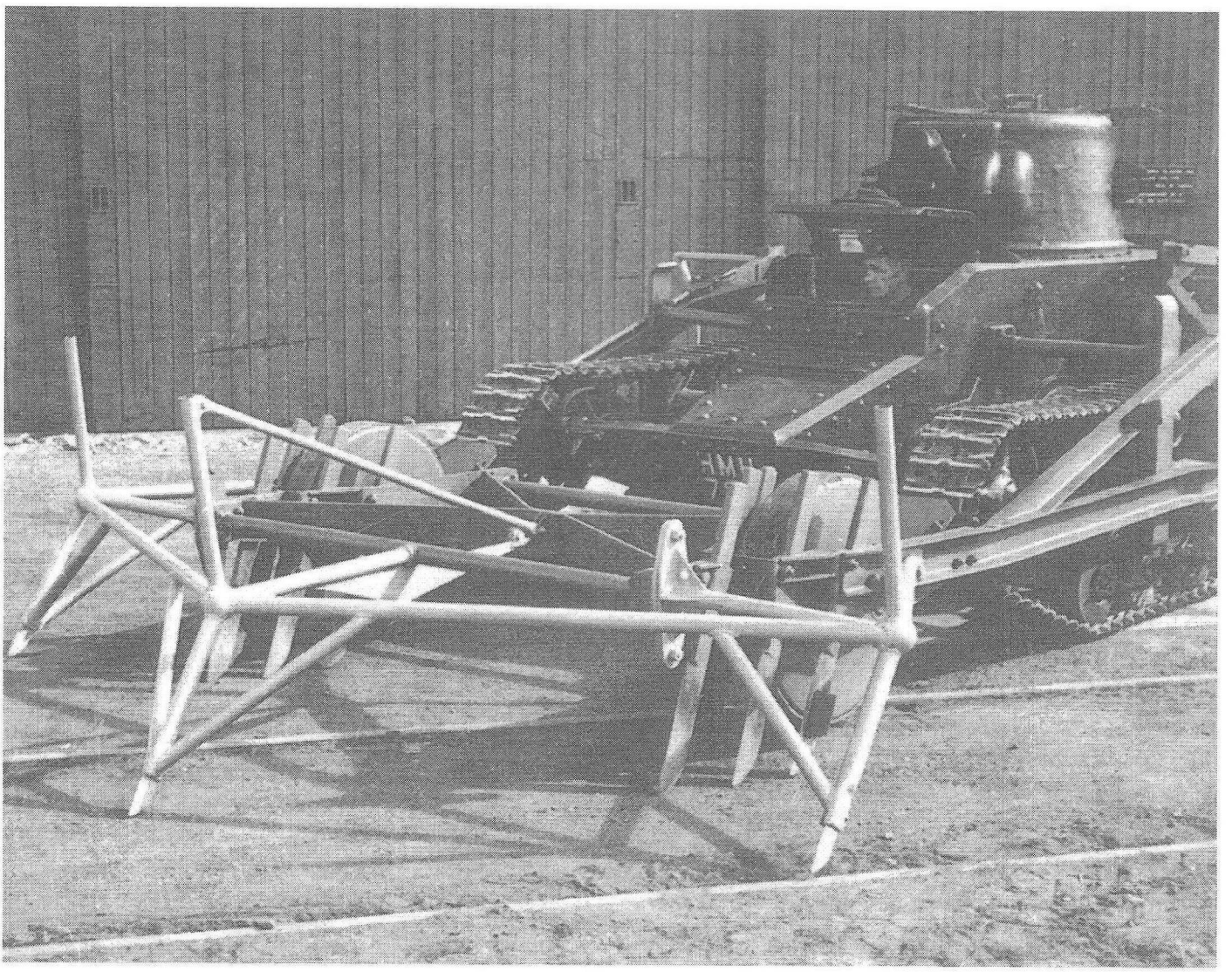
Rear offside three-quarter view of T3439, showing the prominent rearward projection of the final drive casings, due to their rotation to raise the sprocket rings. The tank has yet to receive the bin for the jacking blocks, while the Bowden cables have not been attached to the 4-in (10 cm) smoke dischargers. *(National Archives)*

output shaft to the winch gear, a protective cover being provided for when the winch gear was not fitted. As far as operating the winch was concerned, the meeting minutes elucidated that "It was agreed that the two controls from the driver to the winch gear should be built in as part of the tank, and that provision should be made for the selector rod to fold out of the way when the winch gear is not fitted." The selector rod engaged and disengaged the power take-off, while the main control rod actuated the winch and set its direction of rotation (*i.e.* for raising or lowering the plough). As previously suggested, the socket mountings for the guide plate connecting tubes would be fitted as standard production fixtures, the minutes recording that "It was finally decided that M.E.E., assisted by a draughtsman from C.I.A., should produce drawings of the tank, including details of the control rod positions, sockets for outrigger brackets, rear top door and stowage of equipment where this is affected." It was moreover mentioned that "The drawings produced at M.E.E. will be sent by C.I.A. as soon as possible to Messrs. Vickers, Elswick, as a guide for the production of the second batch of 60 Infantry Tanks, Mark I." These tanks were of course due to be produced at Scotswood, although Vickers' production drawing office was at Elswick. The early production Infantry Tank Mk. I's had experienced serious overheating during their CIA acceptance tests, these tests being assessments of each individual vehicle to ensure they conformed to specification before they were released into service. This was the main reason why T3433 had been delivered to the MEE for evaluation. This vehicle weighed 10.7 tons against the 10.32 tons of A11E1, the difference being partially due to the new design of turret with 65 mm thick armour. Other changes to production tanks that would have affected the weight included a change to the bogie mounting brackets, which now included a dedicated spindle for the track return wheels so that they were no longer bracketed to the suspension. A No. 11 Wireless Set was installed in the offside rear of the fighting compartment, its aerial being located on an overhanging bracket attached to the offside side plate just behind the turret, and the wiring for the commander's headset being connected via the rotary junction. A rearview mirror for the driver was also provided, which hinged on the front face of the offside stowage box.

MEE Report A45/24 of 29th August detailed a pair of cooling trials that had been conducted on T3433, the first with the standard production cooling fan, and the second with Vickers' experimental revised design, which featured an increase in the width of the fan blades. In both cases the radiator was the standard Ford type as fitted in production. Four runs were undertaken in each of the two trials, with only the water temperature being measured, the lubricating oil temperature being discounted. For the standard production fan, the maximum water temperature difference over ambient measured during the four runs was 139 °F (59 °C), while for the experimental fan the maximum water TD was

130 °F (54 °C), the report opining that "It would appear that a reduction in temperature of about 10 °F [5 °C] can be obtained by using the experimental type of fan." T3433 had already been governed down to 6½ mph (10.5 km/h), and it was decided to further reduce the governed speed to 5½ mph (9 km/h), this producing a maximum water TD of 128 °F (53 °C) with the experimental fan, a drop of 2 °F (1 °C). After 205 miles (330 km) of running T3433 had to be taken off testing in order to be fitted with the modified mine plough, and so it was replaced with another early production machine, T3439. This had been borrowed from the 4th Battalion of the Royal Tank Corps (4 RTC), who were the first designated unit to be equipped with Army tanks. According to MEE Report A45/25 of 9th September, T3439 was subjected to another pair of cooling trials, these comparing the first Vickers experimental cooling fan with a second experimental fan that had also been designed by the firm. Three runs were undertaken with each fan, with the maximum water TD produced with the first experimental fan being 127 °F (53 °C), and the equivalent water TD generated with the second fan being 123 °F (51 °C), an improvement of 4 °F (2 °C). A further check was made with the second fan, when it was subjected to three runs with the ventilating outlet louvres in the engine compartment roof being fitted with 4 in. (10 cm) blanking strips at their rear, these having no adverse effect on the cooling performance. It was then decided to combine the second experimental fan with the stepped Gallay radiator fitted in A11E1, which was weighted up to 10.7 tons to represent a production machine. A series of four runs were conducted over the usual two-mile (3 km) circuit, at an approximate speed of 5 mph (8 km/h) and with the ventilating outlet louvres being blanked off for 4 in. (10 cm) at their rear, these generating a maximum water

Infantry Tank Mk. I T3433 at the MEE at Farnborough on 18th September 1939 with the coulter plough attached, which on this occasion had been fitted with a wire-clearing attachment. This view clearly shows the forward guide plates for the plough frame, and their supports mounted on the hull sides. *(The Tank Museum)*



TD of 116 °F (47 °C) and maximum lubricating oil TD of 103 °F (39 °C). MEE Report A45/26 of 15th September would therefore conclude that "the cooling shows a decrease of 7 °F [4 °C], as compared with the results obtained when using a Ford radiator." It should be noted that by this juncture, A11E1 had accumulated 2588 miles (4165 km) of running, of which 504 (811 km) had been on road and 2084 (3354 km) across country.

During August contracts were issued for the 90 outstanding Infantry Mk. II's (A12), with ten being ordered from the LMS on 11th August, and forty each being contracted from John Fowler and Ruston & Hornsby Ltd. on 25th August, this bringing the total on order to the requisite 220. Mechanization Board Minute A3002 was issued on 19th September, which dealt with a request that Alexander Davidson had made on 1st June for the provision of gas detection paper for the current range of prototype and production AFV's. The potential use of poison gas was at this time viewed as a distinct possibility in a future war, the gas paper itself being of a distinctive yellow colour, and being issued in six inch (15 cm) squares. Although these squares were to be fitted externally, it had initially been hoped to position them so that they were still visible when the vehicles were closed down, although this had not proved practicable. Nonetheless, the minute confirmed that the papers were visible under approach march conditions, when either the driver's or the commander's hatches were open. In the case of the A11, it was designated that one of the papers be mounted on the turret roof, and the other on the front glacis plate of the hull, the holder for the paper being manufactured from sheet metal, and being affixed by existing bolts were possible. The trials during August of the Fowler mine plough fitted to T3433 had been interrupted after 100 miles (160 km) by a defect to the selector gear that engaged the power take-off. The investigation into this fault was set out in MEE report A64/5 of 23rd September, which identified the source of the problem as the 0.25 in. (6 mm) pin that was located in a cannelure (*i.e.* a groove) in the body of the sliding engagement gear, and slid the gear forwards by means of a rotating operating lever. However this lever not only moved the pin horizontally, but also raised it vertically to the top edges of the cannelure, where it ran the risk of disengaging from the cannelure entirely. In addition, as the pin was only supported by the lever at one end, it was subjected to severe bending at its root and was insufficiently robust to withstand the load. The report consequently confirmed that "A new pin manufactured of 3% nickel steel has been fitted and positioned at the lowest point in relation to the operating lever, in order to maintain engagement throughout the travel of the sliding wheel." It was further speculated that "Although the present arrangement is proving satisfactory, it is thought that some redesign of the selector should be undertaken, possibly to include an orthodox sliding fork", an orthodox fork being one which actuated longitudinally rather than radially.

MEE report A82 of 15th October documented a series of trials to assess the vulnerability of the A11 to attack with the kind of improvised incendiary devices that might be encountered in the Infantry support role. In order to facilitate them a mild steel mock-up was made of the A11's engine compartment, which was furnished with an unserviceable engine replete with carburettor, and the distributor and high tension leads of the ignition system, these items being considered particularly vulnerable to flames. A remotely driven fan was also installed to simulate the effect of the standard engine compartment ventilating fan. Three types of incendiary were employed in the tests, these being petrol bombs, magnesium bombs and thermite bombs, and before each stage of the trial the float chamber of the carburettor was filled with petrol, while a tray containing a mixture of petrol and lubricating oil was placed under the engine to simulate typical leaks on the hull floor plate. The various incendiary devices were placed by hand in positions where they were liable to lodge in an attack (for example in the recesses of the engine ventilation outlet louvres) and then ignited, the ideal condition being to ignite the lubricating oil in the bottom tray, which would produce a fire that persisted sufficiently to cause extensive internal damage. In the case of the petrol bombs, the report relayed that "Ignited petrol ran into the engine compartment and a small fire attributed to the petrol in the tray was initiated which burnt itself out without firing the lubricating oil." It was subsequently found that "No damage whatsoever was caused to the engine." The next munitions to be assessed were the magnesium bombs, which were actuated under the same conditions as the petrol bombs, it being recalled that "Molten ignited magnesium fell into the engine compartment, but again only a small fire was initiated which burnt itself out without damaging the engine." Finally, the thermite bombs were employed, thermite being a composition of metal oxides and metal powder that when detonated produces a brief but very intense incendiary effect. These were the most successful of the three types of incendiary, as:

> The action of the bomb did not penetrate the mild steel plating on which the bomb was resting, but the molten iron falling into the engine compartment caused the ignition of the oil in the tray and a serious fire was caused which would probably have stopped the engine if it had not been extinguished.

Report A82 concluded that "Provided that there are no petrol leaks in the engine compartment, the vehicle should not be set on fire by bombs of the petrol

or magnesium variety", and that "Thermite bombs, however, will fire any oil on the floor of the vehicle and initiate a serious fire." This indicated that thermite could directly ignite the lubricating oil regardless of whether any petrol was present. It was however underscored that "By ensuring suitable drainage of the engine compartment floor and making it accessible for cleaning, a great degree of immunity from fire is conferred on the vehicle" and that "The best protection would appear to be the elimination of any ledges, etc. on which bombs of this variety can lodge." On this latter point, it should be recalled that the engine ventilation outlet louvres were fitted with expanded metal mesh guards on production machines, although the rear number plate and the exhaust silencer also provided opportunities for lodgement. On 5th November the MEE issued a final wrap-up report on the Fowler mine plough, explaining that the modified selector gear for the power take-off had now been subjected to severe trials on T3433 and was operating satisfactorily. As a result, production drawings for it had been prepared and handed over to both John Fowler & Co. Ltd. and the Chief Inspector of Armaments. Trials of John Fowlers' modifications to the side arm pivot pins had shown that they were less efficient than the original MEE design, and had the effect of twisting the inner vertical strut when the tank attempted to disengage by reversing away from the plough. A meeting at the MEE on 25th October had therefore decided to revert to the original MEE design, with the second batch of sixty A11's being scheduled to incorporate the appropriate fittings to utilise the plough when required. Mechanization Board Minute A3021 of 16th November addressed the results of the recent cooling trials, and the successful performance of the second experimental Vickers-Armstrongs cooling fan and Gallay radiator. The Board's 'A' Committee therefore made the following recommendations:

> (a). Tanks, Infantry, Mark I already delivered and those at present in production be fitted with the modified fan to Messrs. Vickers-Armstrongs' drawing 7074V.C
>
> (b). Tanks, Infantry, Mark I ordered on Contract T/5429 and T/4319 be fitted if possible with either a Gallay or Morris radiator tube block instead of the present standard Ford pattern. These tube blocks are similar in construction, and experiments carried out at the Mechanization Experimental Establishment have indicated a slight superiority of the Morris block as compared with the Gallay.

The Morris radiator had not been the subject of any MEE reports, although this did not prevent the Director of Mechanization, Alexander Davidson, approving the implementation of these recommendations on 25th November. Further firing trials had been conducted at Farnborough in order to assess the possibility of bullet splash entering the vehicle, and on 24th November the results of these were sent to Vickers-Armstrongs. Tests had been carried out with both rifle and machine gun fire, these indicating that the driver's hatch permitted sufficient ingress of splash to injure the driver himself, the door of the hatch also being liable to jamming due to the excessive bevel on its edges. The turret arrangement was however judged as sound, there being no sign of splash penetrating the gun mounting. There was also no evidence of splash passing through the plate joints in the hull, although the design of the engine cooling louvres permitted the entry of sufficient splash to short out the spark plugs. Bullet proof glass visors were provided for both the driver and commander, and although these successfully deflected bullets it was also discovered that they would shower glass splinters into the faces of their users when hit. It was posited that the ball mounting for the driver's periscope ball would need to be case hardened as there was evidence of sufficient scouring which to cause it to jam. Vickers in turn undertook to replace all the issued ball mountings with case hardened ones, and they would also introduce a splash guard on the driver's visor plate in future production. As the cartridge ejector tube on the gun mounting (which ejected externally from the turret) had proven unsatisfactory, this would also be updated on service machines.

In the meantime, the Treasury had approved a £9 million training scheme for the Territorial Army in anticipation of their expansion, as solicited by War Office Memorandum No. 485, with part of this being allocated for the purchase of another 29 Infantry tanks for their familiarisation. As a consequence, Mechanization Board Minute A3044 of 1st December would announce that contract T5429 for the second batch of 60 Infantry Tank Mk. I's, would be increased to 79 such tanks, this bringing the total of A11's on order to 139. Similarly, contract T5115 for the 130 Infantry Tank Mk. II's ordered from the Vulcan Foundry would be increased to 140 machines, thereby raising the total of A12's on order to 230. The second production batch of A11's would incorporate a number of modifications, the majority of these pertaining to the coulter mine plough, which would become an optional fitment on these vehicles. The winch for the plough would be of a more robust design than that employed during the trials at the MEE, and its installation, along with the bracketry for mounting the plough frame, would necessitate a reapportioning of the stowage and VRM plates. As such, the hawser (*i.e.* tow rope) position would be moved from the central offside side plate to the nose of the vehicle, while the spade, machete and

crowbar on the front nearside plate would be swapped with the starting handle on the rear offside side plate. The lifting jack and its handle would be relocated from the rear plate to the rear nearside side plate, slightly displacing the track adjusting tool, and causing the pick handle (or "helve") to be reallocated to the front offside side plate. As recommended by MEE report A64/2 the external stowage bins would be redesigned, becoming taller and longitudinally narrower to allow the forward mounting of the coulter frame, while the pyrene fire extinguishers would be moved rearwards on both sides of the vehicle. The holes for the sockets for the tubular supports of the guide plates were drilled into the hull just behind the stowage bins, although the sockets themselves were not mounted, the holes being closed with the attachment bolts. These holes would also be retrospectively drilled in existing tanks and likewise bolted closed. Both ventilation inlet blanking plates would be mounted slightly lower down on the hull. The rear number plate would be shifted from the rear plate to the offside trackguard, and the jacking blocks to the nearside rear of the engine deck. Also, a protective shroud would be added to the rear plate of the engine deck to protect the winch drive, this having a circular rear cover for when the plough wasn't fitted. Perhaps the most characteristic change prompted by the relocation of the stowage was that the headlights were also repositioned, these being fitted lower and further forwards on the support brackets for the nose plate, the rearview mirror being similarly relocated.

One modification that did not relate to the coulter plough was to the driver's visor, the original letterbox design being superseded by a recessed slit with a hinged armoured cover. This was biased to the offside of the driver's compartment, his periscope in turn being shifted towards the nearside, although an initial shortage of the new design of visor would mean that a few of the first machines from the second batch would incorporate the original letterbox visor. A splash guard would also be incorporated along the top of the driver's visor plate to protect the joint with the hatch. A final comparative cooling trial had been conducted on T3433, between the standard Ford radiator and an equivalent from the Coventry Radiator and Presswork Co. Ltd., this being delineated in MEE report A45/27 of 16th December. Six runs were conducted with the Ford radiator fitted, and four with the Coventry, with Vicker-Armstrongs' latest cooling fan being utilised in both cases. The maximum water temperature difference measured with the Ford radiator fitted was 120 °F (49 °C), while that with the Coventry radiator installed was 123 °F (51 °C). The report pronounced that "The increase of 3 °F. [1.5 °C] recorded with the Coventry radiator, is probably due to the course being in a worse condition than when the trial with the standard radiator was carried out it being more difficult to maintain full load conditions in the latter case." Nevertheless, the Coventry radiator was clearly insufficiently effective to be considered for service use. The year's progress with A11E1 was summarised in the Fifth Report of the Mechanization Board, of 31st December 1938, which recollected that:

> This vehicle covered 2,096 miles [3373 km] during the year without serious breakdown. It was used in the development of a plough attachment for enabling vehicles to traverse land mine fields and as a pilot model to indicate the modifications necessary to enable a tank of this type to negotiate wire obstacles. The water cooling system of this vehicle was known to be inadequate for tropical climates and for the purpose of cooling trials a production model Tank, Infantry, Mark I, was delivered to the Mechanization Experimental Establishment in July. A water temperature difference of 116 °F. [47 °C] was finally obtained with a new design of Vickers fan in conjunction with a Gallay radiator in place of the Ford radiator.

The latest status of the production of the Infantry Tank Mk. I was also elucidated, it being remarked that:

> Messrs. Vickers-Armstrongs produced 45 Tanks, Infantry, Mark I, from their Elswick Works, and production on orders originally placed at Scotswood is expected in August. Scotswood will do a good deal of the machining for these vehicles but is gradually dropping out of tank production in favour of gun work.

This of course indicated that there were a further 15 tanks from the first batch of 60 remaining to be built before production transferred to the second batch of 79 machines, these also now being manufactured at Elswick. Regarding individual components, the tracks had been subjected to scrutiny, it being related that:

> Towards the end of the year a twin-drive track in malleable cast iron was designed for Tank, Infantry, A.11. Existing shoes with headless pins and solder plugs as for the cruiser tank were used with special links and twin-drive sprockets. A contract was placed with Messrs. John Maddock and Co., Ltd., for one pair. Trials will commence as soon as this is received in 1939.

The reference to "twin-drive" was to the fact that the sprocket assembly incorporated two sprocket rings which engaged the outside edges of the track links,

this differing from the single-drive sprocket type, in which a single centrally located sprocket ring engaged apertures in the centre of the track links, as was employed on the A9 and A10 Cruiser tanks. The A11 had employed twin-drive tracks from the start of its development, so this new track type did not infer any change in that regard. However, it did incorporate the principle of the tracks employed on the A13 Cruiser tank, which instead of being formed of identical links were composed of alternating "shoes" (which contacted the ground) and "links" (which formed a bridge between the shoes). The links and shoes were joined together by pins which were sealed in their machined lug holes at each end by plugs made of soft metal solder, which deformed into specially shaped annular recesses (known as cannelures) when they were hammered into position. The report also mentioned that:

> As a result of complaints of tracks breaking when swinging in soft ground, an investigation was made jointly by the Board and Messrs. Vickers-Armstrongs, Ltd. The latter were producing a deflector to endeavour to keep soft earth from packing between the track and the sprocket.

This "deflector" would be a scraper positioned just in front of the sprocket in order to scrape mud from the inner surface of the track before it was taken up by the sprocket rings.

3. NEW PRIORITIES

In late January 1939 the British government was alarmed by a German disinformation campaign that suggested that they were planning to invade the Netherlands the following month with the aim of using Dutch airfields to launch a strategic bombing campaign against Britain. The French had indicated an unwillingness to oppose such an offensive without British assistance, thus forcing the Prime Minister, Neville Chamberlain, to abandon the doctrine of limited liability and return to the Continental commitment. As a result of what would become known as the "Dutch War Scare", the Prime Minister had ordered the Chiefs of Staff to discuss avenues for collaboration with their French counterparts, and had issued a public declaration that any German move into the Low Countries would be regarded as grounds for an immediate declaration of war. Chamberlain also decreed a major expansion of the Army, this having the effect of moving the focus of the rearmament programme onto the Army, which had been comparatively neglected while limited liability was in force. The return to the Continental commitment also meant that the Middle East would return to its previous status as a backwater. By 1st February 1939 delivery of 37 Infantry Tank Mk. I's had been made to the service, of which one (T3433) was at the MEE, six were at the AFV Schools (Bovington and Lulworth), twenty were with the 4th Battalion RTC, six with the 7th Battalion, and four at the 8th Battalion. On 15th March, a meeting was held on the tank programme, attended by Harold Brown, Maurice Taylor, Ronald Adam, Frederick Hotblack, Laurence Carr, and Alexander Davidson. This very day would also see Nazi Germany supplementing its previous annexation of the Sudetenland, as permitted by the Munich Agreement of the previous autumn, by invading the rest of Czechoslovakia, this bringing the Continental commitment even more sharply in focus. Adam, as DCIGS, stated that the A9 was now "useless for war in a Western theatre of operations and all of them should be allocated to Egypt or to reserve." It was thus proposed to distribute the majority of the A9's and A10's to Egypt, orders for the former now standing at 125 and for the latter at 100. These types would therefore no longer to be considered as part of the Heavy Cruiser allocation, as laid out during the meeting in Harold Brown's room on 16th May 1938, but were essentially obsolescent standard Cruisers that were to be sidelined in the Middle East. The Light tanks were also now considered obsolescent, as their reconnaissance role was to be increasingly undertaken by "Wheeled Tanks", which were to be turreted armoured cars armed with an anti-tank weapon. There were nonetheless 285 A17's on order, these now being designated as the Light Tank Mk. VII, although they retained the potential to be used as Light Cruiser tanks in an emergency.

There had been another rethink on the role of the A13, with Adam asserting that "Light Tank units would in future have Cruiser Tank (A.13) squadrons to provide gun power." This initiative had been necessitated by delays in a programme to adapt the 15 mm ZB vz.60 autocannon as the standard weapon for Light tanks, the intention being for each Light tank unit to have one of its three squadrons equipped with A13's, this entailing an amended requirement for 282 Light Cruisers. As 195 A13's had already been ordered (65 Mk. I and two batches of 65 of the more heavily armoured Mk. II), a further 87 would be needed to meet this demand. Alexander Davidson then revealed that a new version of the A13, the Mk. III, was being designed, this vehicle being able to accommodate either petrol or diesel ("heavy oil") engines. Ronald Adam hoped that a portion of the additional 87 A13's might be built to this standard, and suggested that this number might be increased up to a maximum of 209 if the A13 Mk. III design proved satisfactory. Harold Brown then pointed out that in the present approved programme there were 211 Cruiser Tanks remaining to be ordered, of which 138 had been reserved, and the remaining 73 intended to be A13's. This meant that the current programme was for 631 Cruisers, indicating a rise over the 585 previously requested by the War Office in their Memorandum No. 343 of 2nd May 1938, and approved by the Treasury on 4th May. This figure rose to 645 with the proposal to increase the number of outstanding A13's from 73 to 87, and having the potential, given DCIG's remarks, to rise further still.

The increase to 631 Cruisers had been prompted by War Office Memorandum No. 485, on the Territorial Army Training Programme, which had demanded an additional 47 Cruisers for this purpose, thus giving an actual total of 632 Cruisers (*i.e.* 585 + 47). The number of reserved Cruisers would concomitantly be 139, consisting of an existing requirement for 92 Heavy Cruisers (*i.e.* A14, A16, or Vickers-Armstrongs' new A18), plus the 47 tanks requested for the TA. The training programme was being implemented as part of a proposal to double the size of the TA from 13 to 26 Divisions. Six Territorial infantry battalions had in fact been converted to Royal Tank Corps Battalions during 1938, and the increase in the size of the TA would see each of these being duplicated in order to form a total of twelve TA armoured battalions. However, the equipment for

these units, which was to mainly consist of Infantry tanks, was still some distance in the future. If the Cruisers for the Territorial Army were to be A13 Mk. III's, these would be equipped with diesel engines in order to provide commonality of fuel with the A12's that would eventually constitute the majority of their equipment. Finally it was acknowledged that 369 Infantry tanks had by this time been ordered (139 A11 and 230 A12), and it was agreed that 60 more A12's could be ordered for the TA, these to be built at the LMS's works at Horwich. On 4th April, the Royal Tank Corps would complete their long anticipated merger with the Cavalry to form the Royal Armoured Corps, with the former RTC battalions being refounded under the rubric of the Royal Tank Regiment (RTR). As such, the 4th Battalion of the Royal Tank Corps would become the 4th Battalion of the Royal Tank Regiment, or 4 RTR. Also on this date, Ronald Adam would minute Harold Brown on the revised provision of Infantry tanks in light of the doubling of the TA's requirement. The DCIGS noted in passing that:

> The Infantry Tank Mark I (A.11) is not acceptable because it is an obsolescent machine. For training purposes I intend to use Light Tanks, surplus to our present requirements, which were originally intended for sale to Greece and Turkey. Such sales must now be limited to very small numbers.

This would effectively sideline the A11 which, after it had been progressively replaced with A12's, would not even perform a training function, the Light tanks having the advantage of a two-man turret. As regards the Infantry Tank Mk. II, Adam outlined that the six TA Army tank battalions would require 50 machines each, for a total of 300 tanks, while a 90% reserve requirement would necessitate a further 270 tanks for a total of 570. As 29 Infantry tanks had already been ordered as part of the £9 million training scheme, this number could be reduced to 541, although Adam appears to have been unaware that 19 of these machines were in fact A11's. The additional 60 A12's approved during the meeting on 15th March would further lower this total to 481 tanks, with the DCIGS stating that "I agree to orders now being placed for 481 Infantry Tanks Mark II (A.12) for delivery as soon as possible." It should be recognised, however, that the expansion of the Territorial Army would in fact create twelve Army tank battalions, so Adam was in fact only catering for the initial "doubling" from three battalions to six. The urgent need for effective Infantry tanks had prompted Harold Brown to broach with Robert Micklem the rather forlorn possibility of fitting the 2 pounder in the Infantry Tank Mk. I, as recollected in a confirmatory letter that the DGMP sent to Vickers on 11th April, this venturing that:

> With reference to my conversation with you and with Mr. Yapp as to the possibility of fitting a 2-pdr. in Matilda and your suggestion that the Valentine design you put forward a year ago might meet these requirements, I write to let you know that provided you can give us reasonable deliveries, it is probable that we can place an order with you for about 100.

The "Mr. Yapp" alluded to here was Frederick Yapp, who was joint head of Vickers' sales organisation, alongside Sir Charles Craven. The DGMP must have been fully aware that the 2 pounder would not have been suitable for mounting in the A11, as Robert Micklem had made this clear to him at the meeting in his own room at the War Office on 12th January 1938. Brown then avouched that:

> This decision has been obtained against considerable opposition, since as you know, this design does not meet the General Staff requirements and has been agreed to only for the reason I have stated — That we can get additional 'Infantry' Tanks in this way quicker than in any other.

The assertion that the Valentine was only being considered under duress rather underplayed the fact that the War Office had wasted an entire year in its procurement having firmly rejected it the previous April. The doubling in size of the Territorial Army would be formally announced by the Prime Minister in the House of Commons on 29th March, and approval for its equipment and reserves would be given by the Cabinet on 19th April. The resulting War Office Memorandum No. 799 placed a demand for 262 Cruisers on behalf of the TA, in addition to the 47 requested in Memorandum No. 485, these to nominally be for "embodiment training", their ultimate purpose being to provide the reconnaissance element for the Army (*i.e.* Infantry) tank battalions. This new demand was to be split equally, with 131 Cruisers being destined for existing Territorial units, and 131 intended for the units created by the anticipated expansion. As a result, there would now be 894 (*i.e.* 632 + 262) Cruisers either approved or requiring Treasury sanction. The provision of Infantry tanks within Memorandum No. 799 was more convoluted, as the immediate allocation for the first three TA Army tank battalions had been split between a "war reserve" of 147 machines, these to be combined with the 29 training machines already ordered, and 109 for "embodiment training". This gave a combined total of 285 machines, or 95 per battalion, which also happened to be the same as their establishment strength (50 Infantry tanks) plus their requisite 90% reserve (45 tanks). Once again however, the fact that ten of the initial 29 training tanks were Infantry Tank

Mk. I's was overlooked. These were to be allocated to the first four TA Divisions, with one battalion being assigned to each division, the assumption being that at least one division would always be in reserve. For the immediate expansion towards six TA Army tank battalions (for the next four TA Divisions) another 176 tanks (*i.e.* 29 + 147) had been stipulated to form the "war reserve", with the number of tanks required for "embodiment training" being doubled to 218. This in turn gave the grand total of 570 Infantry tanks, which provided each of the six Army tank battalions with 95 tanks, *i.e.* their full war establishment with 90% reserve. As such, the Territorial Army were being allocated their full requirement as outlined by Ronald Adam, with the "war reserve" and "embodiment training" categories being devices to steer the submission through the Treasury. These outlays were further addressed in War Office Memorandum No. 816 of 23rd May, which noted that the 570 Territorial Army tanks, when combined with the requirement for 340 Infantry tanks for the regular Army, gave a total dispensation of 910 Infantry tanks, of which the Treasury had given verbal sanction for 810. The memorandum outlined that:

> In the case of 'I' tanks a mere duplication of the numbers in the first Territorial Army Contingent of 4 Divisions falls far short of the requirements of the expanded Force based on a total of 26 Territorial Army Divisions. All Infantry Divisions are supported in Corps troops by 'I' tank units and, in addition to the Territorial Army units requiring 300 'I' Tanks apart from any reserves. For production reasons it is desired to release 350 'I' Tanks over and above the 810 already authorised. 100 of these can be found from the difference between the figures 910 and 810 referred to above. The remaining 250 would be against the 300 for unit equipment tanks of the additional 'I' Tank units.

The "additional 'I' Tank units" units referred to here were the six further TA Army tank battalions needed to bring the total number up to the requisite twelve. This implicitly assumed that if and when the full number of 26 Territorial Army divisions had been raised, a maximum sixteen would be operationally active at any time and therefore in need of Infantry tank support. The 250 additional tanks requested would fulfil the unit establishment for five of the six new Army tank battalions (which would also be converted from infantry battalions). However, the principle reason for ordering these machines was in order to facilitate the expansion of manufacturing capacity, as:

> Whilst the release of the 250 'I' Tanks referred to above is an anticipation of the programme covering the full requirements of the 26 Territorial Army Divisions which have been approved by the Cabinet, the release of 250 'I' Tanks is necessitated by the requirements of production and the War Office can give an assurance that the numbers must form a part of the organisation of the 26 Divisions. It will be seen that this number of 250 is part of the equipment numbers only and does not include any reserves.

Regarding Cruiser tanks, it was advanced that in addition to the 632 machines already approved and the 262 Territorial Army Cruisers awaiting Treasury approval, "Further requirements of 391 Tanks arise from the re-organisation of the Regular Mobile Division into two Armoured Divisions for which £5 million has already been approved". The splitting of the Mobile Division was due to the fact that its anticipated size, containing four tank battalions and six cavalry regiments, was now considered too ungainly, the replacement armoured divisions each being composed of two brigades of three battalions each. This accordingly raised the Cruiser dispensation to 1285 tanks, or 653 above the 632 that had been actually approved. Memorandum No. 816 therefore submitted that 238 of the 391 additional tanks for the armoured divisions be added to the 262 TA Cruisers currently awaiting approval, to produce a Treasury submission for 500 tanks. It was acknowledged that these would cost £6 million and the outstanding 350 Infantry tanks £7 million, thus giving a total of £13 million. At the subsequent 227th Treasury Inter Service Committee meeting on 25th May, the Treasury representatives focused on the potential of further orders to generate new production capacity, arguing that there was no point placing continuation orders with existing suppliers until their existing contracts had been completed. As a result they submitted that the proposed expenditure of £13 million need not be fully met until sufficient new production capacity could be found. The following day Kenneth Lyon of the War Office informed the Treasury that:

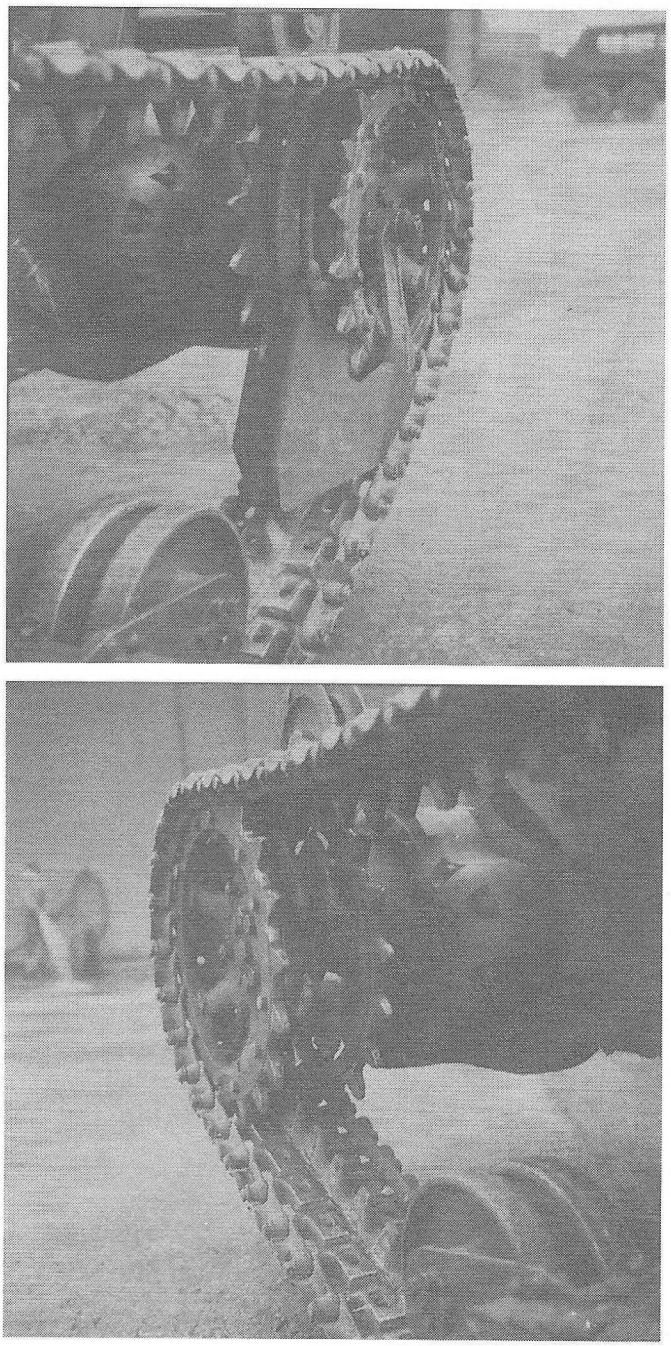
> I have discussed the matter further with Sir Harold Brown. He informs me that to create the capacity he should place orders for a maximum of 430 Cruiser Tanks at a cost of about five million pounds; as regards 'I Tanks' he needs 300 more, these are of the 'Valentine' type and less expensive than the 'A.12' the estimated cost would be between five and six million pounds.

He moreover explained that "Continuation orders would be placed to some extent for the Cruiser Tanks, but new capacity would also be created", while "In the case of the 'I. Tanks' all the orders would mean new capacity." The Treasury in turn responded on 2nd June, agreeing

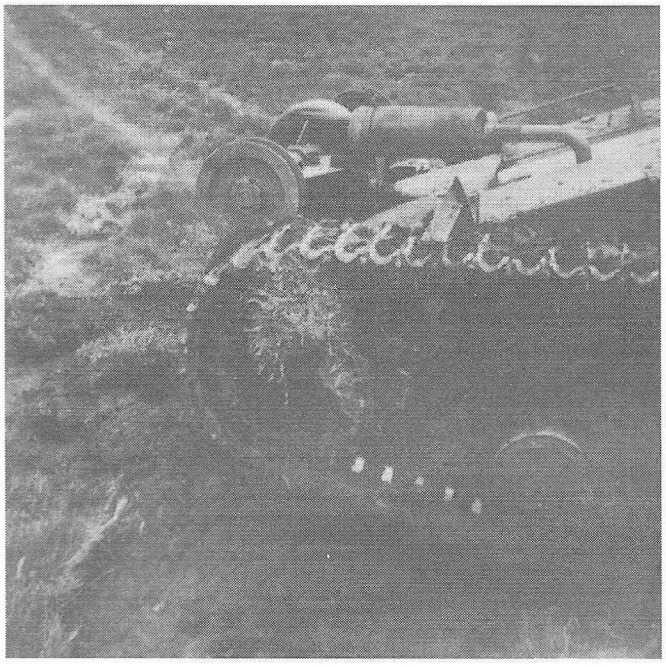
to sanction the 730 tanks that Lyon had set out in his letter. It had already been agreed to order another sixty A10's, therefore bringing orders of that machine up to 160, due to the latest designs of Heavy Cruiser still being longer term prospects. A note entitled *Tank Situation* issued on 29th June revealed that the 300 Valentine tanks had been ordered, along with 671 Infantry Tank Mk. II's and 139 Infantry Tank Mk. I's, this giving a total of 1110 Infantry Tanks (*i.e.* 810 combined A11 and A12, plus 300 Valentines). The question of which Heavy Cruiser tank to adopt had been resolved in favour of a new design which was essentially a lengthened version of the A13 Mk. III, this being given the revived nomenclature of A15. As a consequence, 100 A15's had been ordered alongside 300 A13 Mk. III's, the two designs being intended to form the bulk of future Cruiser production, just as the A12 and Valentine would be the main Infantry tanks. As such the A9, A10, and A13 Mk. I and Mk. II would now, like the A11, be classed as interim designs to be produced in small volumes only. On 6th July the Mechanization Experimental Establishment would compose their report A100/2 on swinging trials that had been conducted on T3433 on 18th May, this stating that:

> Reports of track trouble in units due to links breaking under the extra strain imposed by the sprockets packing in mud, long grass, etc., led to trials at the M.E.E. of an Tank, Infantry, Mk. I, fitted with production guide rings in conjunction with a special plough attachment manufactured by Messrs. Vickers-Armstrongs, Ltd., on the near-side sprocket ... and with guide rings, of the pattern used on the pilot model, on the off-side sprocket ... These latter take the form of segments in place of the two complete rings as used on the production models.

The "plough" mentioned here was a mud scraper mounted in front of the sprocket that was intended to remove mud and other debris from the track before it rounded the sprocket, this being the "deflector" that had been mentioned in the Fifth Report of the Mechanization Board on 31st December. T3433 was weighed at 10.6 tons, and subjected to trials on various types of terrain, it being eventuated that "As the tracks were sufficiently slack (1½" to 2" [4 to 5 cm] sag between top rollers) no breakages were experienced though neither device prevented the track from packing out beyond the sprocket under certain conditions." The first swinging tests were conducted on damp, earthy soil, with both tracks packing after a 180° turn, although they were cleared after four yards of forward movement. For the second swinging test, in gravel, it was commented that "Both types of device were equally ineffective owing to the gravel packing between the guide rings and the sprockets and filling up the gaps between the sprocket teeth, so forcing the track out of engagement with the sprocket." This effect was more pronounced on the offside, where the segment rings were fitted, although it was noted that both tracks once again cleared themselves very quickly after four yards (~4 m) of forward movement. Swinging in clay was the next challenge, this producing no packing, although report



The set-up of the sprockets for the track swinging tests on T3433 as set out in report A307. The nearside sprocket has been fitted with production guide ring and a Vickers-Armstrongs scraper, or "plough", to prevent mud packing. The offside sprocket has been fitted with guide ring segments of the design fitted to prototype A11E1. (National Archives)



These pictures reveal the packing of the nearside sprocket and mud plough while swinging on damp grassland. Visible at the rear of the hull is the original design of winch gearbox for the Fowler mine plough, with its drive connected.

The packing of the offside sprocket while swinging on damp grassland. Of note in the left image is the bracket located between the return rollers. This held the pivot pin for the frame of the Fowler mine plough. (all: National Archives)

A100/2 cautioned that "This is not a conclusive result, as with clay of a different texture, packing might be produced." The fourth and final evaluation was a series of swings in damp grassland, with a familiar result as "These produced bad packing but neither track broke and they were both clear after moving forward 4 yards [~4 m]." Further trials had been conducted on 22nd May against a production tank with the standard sprocket arrangements, this indicating that "the plough as it stands is superior to other arrangements in all but gravel terrain where all are equally ineffective." The MEE noted that the plough was to be modified by being altered in shape and fitted closer to the track, with further trials being anticipated. However, as no further reports on this device would be generated, this course does not appear to have been pursued.

This period would also witness the return of experiments to the engine governing, with MEE Report A107 of 8th July detailing a trial on T3433 with the engine speed governed at 4150 rpm, as against the production

setting of 2820 rpm which produced 70 bhp (52 kW) and a maximum speed of 8 mph (13 km/h). For the duration of this trial the tank weighed 10.32 tons, and covered 96 miles (155 km) with the new governor setting, of which 16 (26 km) were on the road and 80 (129 km) across country. This brought the T3433's total mileage up to 359 miles (578 km), which was evenly divided between road and cross-country work. The increased engine speed yielded a maximum cross-country speed of 10.28 mph (16.55 km/h) over a quarter of a mile (400 m), with the average speed over a two mile (3.2 km) course being 8.9 mph (14 km/h). It was also reckoned that "The ease of gear changing is greatly improved." However during a run on 3rd March, the engine overheated and stopped, a subsequent workshop examination finding significant damage to the engine, especially to the rear pair of cylinders on each bank. This included the fracturing of the pistons, connecting rods and cylinder walls, damage to the connecting rod big end bearings and crankshaft bearings, and the fracture of the nearside camshaft, the MEE Workshops conjecturing that the original cause of failure was the breakage of the big end bearings or the connecting rods in one of the two rear cylinders. A new engine was fitted and the trials continued, although this failed after only 17 miles (27 km) of running due to the cylinder head and piston fracturing in the front cylinder of the offside engine bank. These components were accordingly replaced, although the Workshops submitted that "It is considered that this failure is the result of overheating due to high engine speed; there is no visual evidence of faulty material or construction." Report A107 therefore concluded that "The Ford V.8 engine does not appear to be capable of performing at a speed of 4150 r.p.m. when fitted to this type of vehicle." This was not a surprise, as previous trials had indicated that the cooling of the Ford engine was marginal within the A11. R.G. Shaw, commenting on behalf of the Mechanization Board, declared that:

> The increase in engine speed is not a satisfactory solution to the gear change difficulty. It is expected that the Don-flex clutch lining already recommended for these engines will overcome the clutch trouble that has up to now resulted from the difficult gear change.

A fault had developed with the Fordson gearbox across the numerous vehicle types employing it in service, this being due to the end pinions on the layshaft and mainshaft wearing away the gearbox casing. As a consequence, on 12th June Alexander Davidson wrote to all the regional commands requesting the removal and stripping of all such gearboxes for examination, these then being reassembled with phosphor bronze washers between the layshaft end pinion faces and the gearbox casing. In the meantime the situation on the Continent was becoming more perilous. Following the German takeover of Czechoslovakia in March, Britain had provided a guarantee of military assistance to Poland should it be the subject of external aggression. An attempt by the British and French to form a military alliance with the Soviet Union had failed to yield any concrete results, leading to the Soviets agreeing a non-aggression pact with Nazi Germany on 23rd August which divided Central Europe into respective spheres of influence, whose dividing line went through Poland. In response, Britain formalised its defence alliance with Poland on 25th August, and, after a brief postponement, the Germans went ahead with their intended invasion of Poland on 1st September. Britain immediately ordered the full mobilisation of its forces and along with France sent an ultimatum to Germany to cease its aggression by the 3rd of September or face a declaration of war. This did not garner a response from the Germans and at 1100 hours on 3rd September the Western powers duly declared war, although with little prospect of assisting Poland itself. The Field Force to be dispatched to the Continent would now be known as the British Expeditionary Force (BEF), this initially comprising a General Headquarters (GHQ) and two corps, each incorporating two divisions. This force would include a single Army tank battalion and a pair of cavalry regiments equipped with light tanks, along with its various infantry, artillery and support battalions. It was also expected that a third division would join each corps once the mobilisation was in its stride. On 3rd September the British Expeditionary Force was placed under the command of General the Viscount Gort (Lord Gort), with the first advance parties of the BEF sailing to France the next day, 4th September.

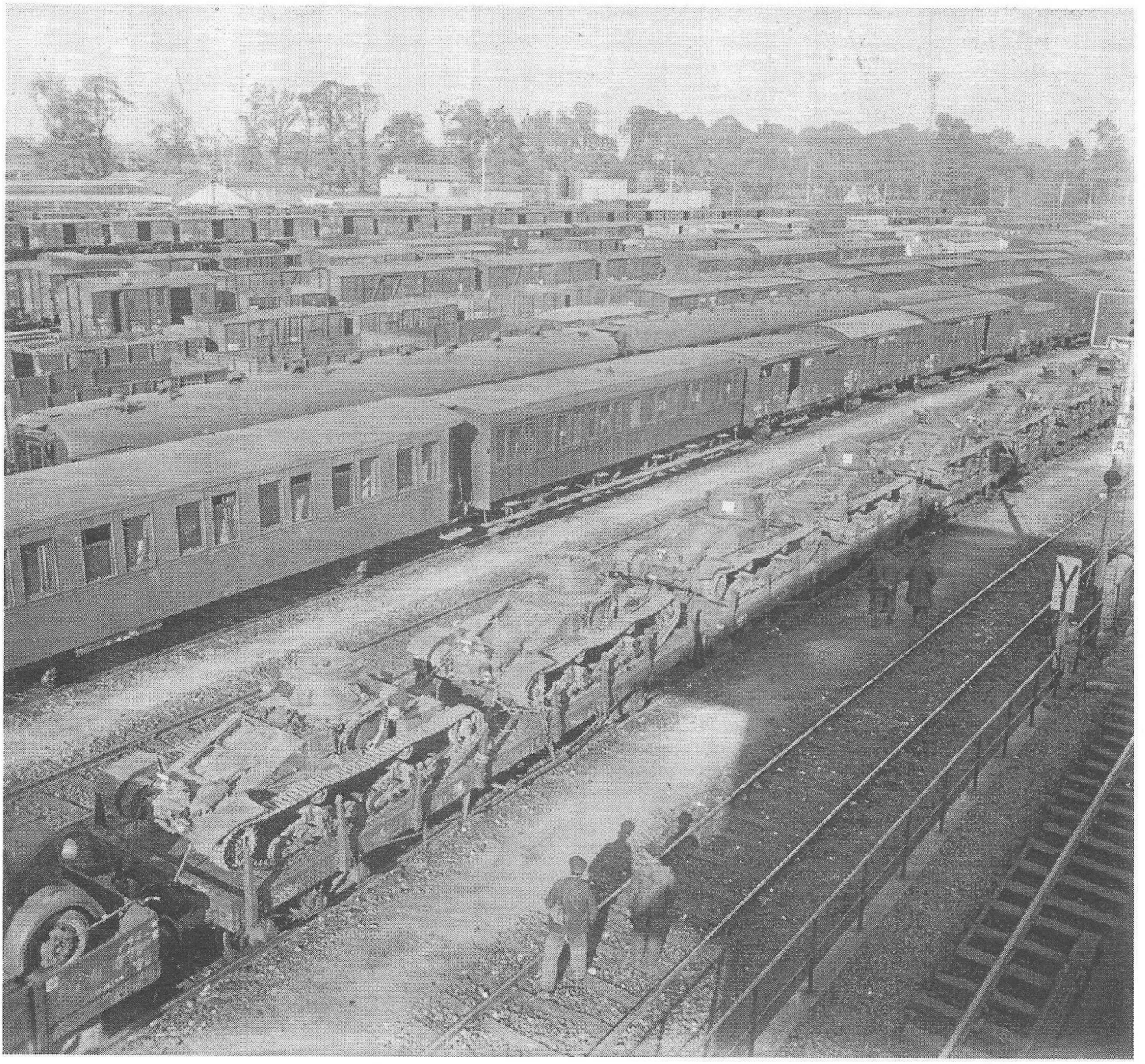
By the beginning of September 67 Infantry Tank Mk. I's had been built from the order for 139, with the majority of these having been issued to the units of the new 1st Army Tank Brigade, which had been mobilised at Farnborough on 1st September under the temporary command of Brigadier John Caunter. This brigade comprised the 4th, 7th and 8th Battalions of the Royal Tank Regiment, with the senior 4th Battalion (4 RTR) having been issued with the majority of the Infantry tanks that the brigade had received. The brigade was widely spread out at this juncture, with 4 RTR being located with the brigade headquarters at Farnborough, while 7 RTR was with the 5th Infantry Division at Catterick Camp in Yorkshire, and 8 RTR was based at Perham Down, near Tidworth Camp in Wiltshire. It was 4 RTR who were earmarked to make the journey to France with the first tranche of the British Expeditionary Force, the war establishment for an Army tank battalion being 50 Infantry tanks and 7 Light Tank Mk. VI B's. These were divided into three companies ('A', 'B' and 'C') of sixteen Infantry tanks and one Light tank each and a battalion headquarters (BHQ)

of two Infantry and four Light tanks. On 3rd September 7 RTR and 8 RTR each sent nine Infantry Tank Mk. I's to 4 RTR in Farnborough in order to make up their establishment, with 4 RTR sending five obsolete Vickers Medium tanks to 8 RTR in return. This would leave 8 RTR with a total tank strength of three Infantry and seven Medium tanks, while 4 RTR would receive a draft of 98 RAC reservists on 4th September, the unit continuing to mobilise over the subsequent four days.

In the meantime, a few miles south of Farnborough at Aldershot a small but significant unit had commenced their own mobilisation on 2nd September. This was the AFV Branch of the British Expeditionary Force's headquarters, known as GHQ(AFV), which sprang into being along with the rest of GHQ's administrative First Echelon on the announcement of the general mobilisation. GHQ(AFV) was headed by Brigadier Frederick Hotblack, the Brigadier AFV (or BAFV), its purpose being to advise Lord Gort and his staff on their policy towards tanks and other armoured fighting vehicles, with Hotblack and his small team having no power to set policy themselves. There were four other officers under Hotblack, these being his senior staff officer (GSO I), Lieutenant-Colonel Richard Lewis, his subordinate staff officer (GSO III), Captain Francis Arkwright, and a pair of technical officers, Major William Blagden and Captain Ardale Vautier Golding (A.V. Golding). These latter were to serve as Deputy Assistant Directors of Mechanization (DADM's), with Blagden having previously been in charge of the 'B' vehicle section at the MEE, and Golding having served in the Design Department at Woolwich under George MacLeod Ross. Golding had been the recipient of a few back-handed compliments from his previous superior, but unusually for Ross they were nonetheless compliments. On 6th September Lieutenant-Colonel Hayman Hayman-Joyce of the Staff Duties directorate visited Aldershot to enquire about any liaison difficulties that were being experienced between BEF GHQ's First Echelon and the various War Office branches. Frederick Hotblack took the opportunity to advise Hayman-Joyce of the preferability of moving 4 RTR to their port of embarkation to France by rail rather than by road, if this could be achieved without disrupting the existing Movement Plan.

Hotblack would in turn visit SD7 at the War Office on the following day, 7th September, where he would be reassured by his old department that it was "now practically certain Bn. R.T.R. would move by rail in England and also overseas, subject to provision of suitable [railway] trucks." Also during this day Richard Lewis had popped up to see 4 RTR at Farnborough, where he was informed by the battalion that they were still deficient of major items of equipment, despite their continuous hastening action. Such items included machine gun fittings and spares for both the Infantry Tank Mk. I and Light Tank Mk. VI B, 'B' vehicles, and spare parts for Bren light machine guns. However, no remedial action would be able to be taken by the AFV Branch, the provision of these stores being the responsibility of Aldershot Command, under whose jurisdiction the 1st Army Tank Brigade were currently placed. Lewis informed the commanding officer of 4 RTR, Lieutenant-Colonel Alec Gatehouse, that his unit was now likely to move to France by rail, whereupon Gatehouse impressed on him that he was "very anxious to obtain at least one Inf.Tank Mk. II to take with him." Lewis responded in the negative, stating that the War Office had decided that no Infantry Tank Mk. II's should be sent overseas for the present time, although in reality production of this machine would only commence during this month, with a bare handful of brand new and untried machines potentially being available by the time 4 RTR was to depart. However, as Gatehouse was formerly in command of the Mechanization Experimental Establishment, he would have had a thorough insight into the superiority of this new machine. Hotblack and Lewis would attend a comparative trial on 8th September between the A12 prototype and an A9 Cruiser tank that had been ballasted to the equivalent weight of the Valentine. As this evaluation did not indicate any superiority on the part of the Valentine in mud performance or obstacle crossing, the view of the observers was that additional orders for Infantry tanks should be concentrated on the Infantry Tank Mk. II.

Also on 8th September, 4 RTR would have their machine gun deficiencies made up by a transfer from the King's Dragoon Guards, this having been authorised by SD7. They would also be informed by Frederick Hotblack that they were now virtually certain to move to France by rail. The battalion would spend the subsequent days in individual training, while on 12th September the AFV Branch would commence their transfer to France, with Francis Arkwright and A.V. Golding entraining at Farnborough station during the morning along with the NCO's and privates who made up the unit clerks, draughtsmen and batmen (*i.e.* servants). This party also took most of the allotted office equipment and technical manuals, boarding the S.S. *Manxman* at Southampton in the early afternoon. This vessel moved off into the estuary of Southampton Water in the early evening in order to form a convoy with four other ships, setting sail for Cherbourg just before midnight. The advance party from 4 RTR would set off for France in the early hours of 13th September, while during the evening of this day the AFV Branch representatives would board a train from Cherbourg to Le Mans, where they would set up their office the next day, along with BEF GHQ's Royal Artillery (MGRA) and Military Survey (MS) branches. Here they would settle in as best they could while awaiting Brigadier Hotblack and their other absent officers, Le Mans being the



Tanks of 4 RTR halted at Caen on their journey east from Cherbourg to the Arras vicinity, these being attributable to 'B' Company by the yellow square painted on the turret rear. *(archives départementales du Calvados)*

assembly area for the BEF before it moved north to the frontier with Belgium. The BEF's General Headquarters and its two Corps (1st and 2nd Corps) were expected to arrive in France over the last week of September and the first week of October. 4 RTR received orders for the move of their rail party, which would include their tanks, on 15th September, while the orders for the move of their road party, which would include their wheeled 'B' vehicles and the bulk of their supporting personnel, were received the following day.

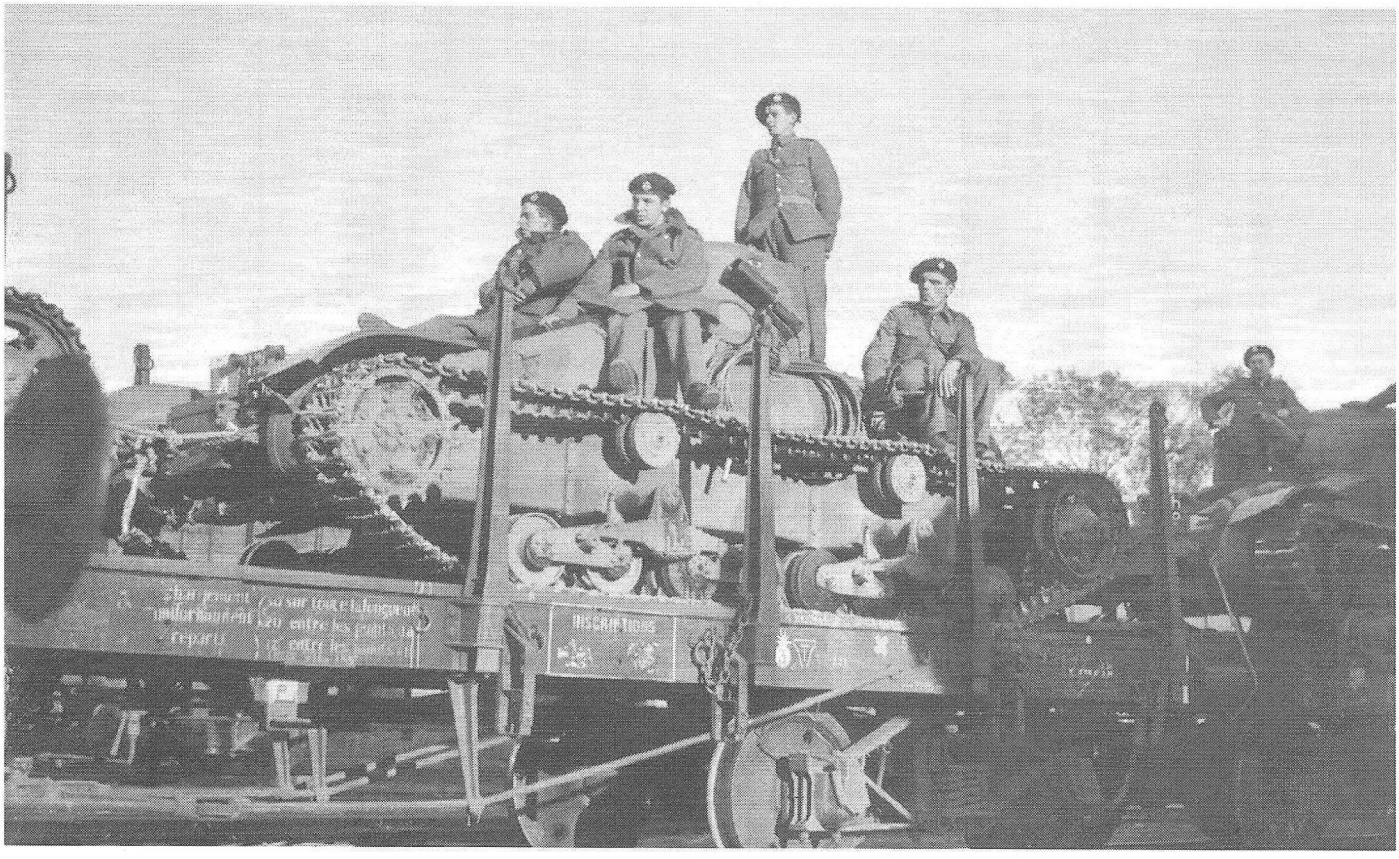
On 17th September 4 RTR loaded their 50 Infantry Tank Mk. I's at Farnborough station, with the rail party moving off on three trains the following afternoon, 18th September. These trains departed an hour apart, with two trains carrying 25 tanks, two officers and 50 men sandwiching a single train carrying a pair of officers and 230 men. In the meantime, Frederick Hotblack had caught up with the AFV Branch at Le Mans in the early morning of 17th September, with William Blagden arriving the next day, although the branch's office equipment was still in transit. 4 RTR's road party would depart from France on 19th September, this including the unit's Light Tank Mk. VI B's, one of which would be the only vehicle casualty on the journey to Southampton, as it succumbed to steering trouble. All the battalion's tanks were embarked on this day,

while over at Le Mans the AFV Branch would document that "Information received that 4 R.Tanks will arrive CHERBOURG 21 Sep, and will move direct by train to concentration area to arrive there between 29 Sep – 1 Oct." During the afternoon of 20th September the personnel of 4 RTR marched from their rest camp to the docks at Southampton and boarded the S.S. *Biarritz*, which moved off into Southampton Water in the late afternoon to await its escorts. The *Biarritz* would berth at Cherbourg shortly before midday on 21st September, with 4 RTR's war diary noting that "Some of the vehicle ships had already arrived & unloading was begun immediately." They would be met here by Frederick Hotblack, William Blagden and Richard Lewis, the latter of whom had arrived at the AFV Branch at Le Mans the previous day having led its rear party. The branch's diary would proudly declare that "On this day the first British tank to land in France was put ashore", with "No difficulty in unloading." 4 RTR's battalion headquarters and their tanks were to be billeted at the nearby Château de Martinvast, while the rest of the battalion personnel were to be accommodated at the French army camp at Village de la Roque. The unit's first line drivers would however remain at the docks at Cherbourg to unload the vehicles, this task continuing over the next three days. On 22nd September, the AFV Branch would relate that:

> There seems to be no doubt that a good deal of pilfering from vehicles took place on the cross channel journey. 4 R.Tanks lost minor but important items of equipment. Some vehicles incurred large losses. This seems to be due to the plan by which vehicles were *not* accompanied by personnel of the unit travelling in the same ship.

This was unfortunately a harbinger of problems to come, with pilfering being an endemic feature of vehicle and equipment transport throughout the war, the culprits being distributed between military personnel, dockworkers and other transport operatives, and local civilians, both in the United Kingdom and abroad. Despite this risk, tanks would continue to be shipped separately from their unit personnel throughout the conflict, and even tanks on the battlefield would be prone to being looted the moment they were left unobserved. On 26th September the AFV Branch received a warning order of the move of GHQ to the BEF's concentration area west of Arras, in the Pas-de-Calais department of northern France. The advance party of 4 RTR set off on the 270 mile (430 km) journey northeast to the concentration area during the morning, the rest of the battalion receiving their movement orders later in the day.

Close-up view of a tank of 4 RTR on the journey to Arras. Note that the towing cable is stowed in its correct position on the offside hull, the tanks being lashed together, and to the flats, via hemp rope. (IWM O577)



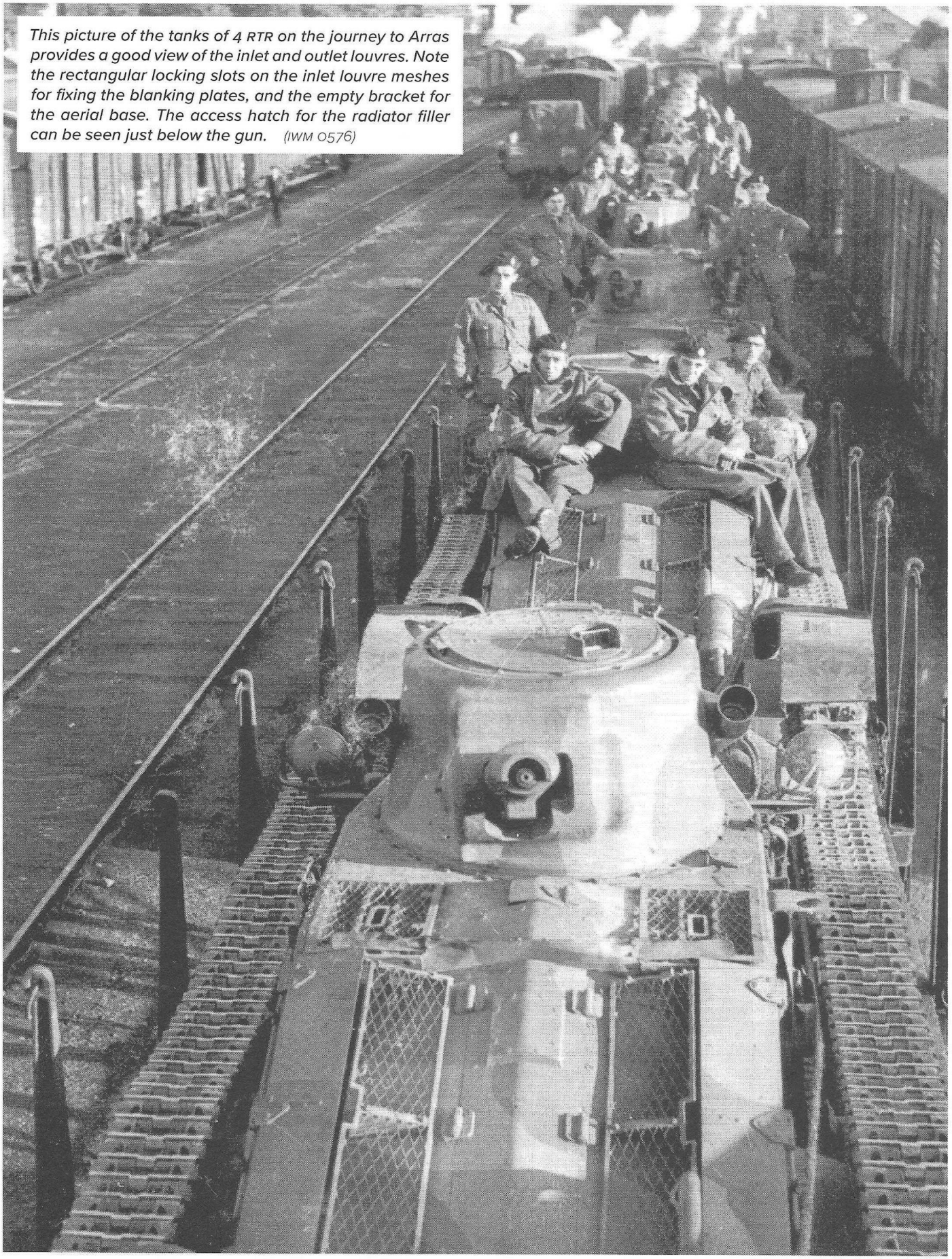
On 27th September the AFV Branch enquired with GHQ's Quartermaster's ('Q') branch, and its Assistant Director of Transport, about the 2nd and 3rd echelon transport arrangements for 4 RTR, being informed in response that these did not exist. The 1st echelon transport for the unit was its own 'B' vehicles, the second and third line transport being the means by which the unit's supplies were delivered to dumps or depots which its own transport element could draw from. 4 RTR were due to be billeted in the area occupied by 1st Corps, with GHQ's staff directorate informing the AFV Branch that the battalion would be catered for as regards feeding arrangements, but that special provision would have to be made to supply them with petrol.

Although the bulk of the development work on the Infantry Tank Mk. I had been completed, trials would still continue at the MEE on the few outstanding items, as well as on speculative experiments. An example of the latter was delineated in MEE Report A150 of 18th September, which detailed a test on T3433 in which the idler wheels were moved 14¼ in. (36 cm) forwards and 4¾ in. (12 cm) upwards in order to determine whether this improved the trench crossing capacity. The tank was driven over "natural" trenches that had been dug into damp sandy soil, it being discovered that the modification provided no improvement whatsoever, the report attesting that "The limiting factor in both modified and standard vehicles being the tail of the vehicle dropping into the trench." It was nonetheless mentioned that "The extra length did, however, ensure that the idler wheel landed on the far bank before the vehicle started to drop its nose, but no benefit resulted from this." Back in France, 4 RTR boarded three trains at Cherbourg on 28th September, along with their tanks and vehicles, and detrained the next day at Aubigny-en-Artois, ten miles west of Arras, although their 'C' Company detrained at Arras itself. These detrainments were witnessed by William Blagden of the AFV Branch, whose report emphasized the need for orientating railway wagons and ramps to facilitate tanks being driven off forwards with the minimum of shunting, which was a time-consuming procedure. These points were underlined by Frederick Hotblack, who stated that "It will be of first importance to be able to move by rail considerable numbers of A.F.Vs in the shortest possible time during or prior to operations." This was an extremely notable comment, as it revealed that the British were blithely assuming that the railways would be an integral part of armoured movements, as they had been during the previous war. Such an assumption would in turn tend to provide at least some insight as to why they had paid so little attention to the automotive durability of their tanks, an omission that the Germans had fortunately replicated. 4 RTR's battalion headquarters (BHQ) and 'B' Company were to be billeted at Écoivres, their 'A' Company at Acq, and 'C' Company at Mont-Saint-Éloi, these villages all being a short distance to the northwest of Arras. The battalion were now under the orders of 1st Corps, with their personnel train and their road party arriving over the next couple of days, the latter having travelled via Le Mans and consisting of vehicles that were too tall to travel by rail. In the meantime, Richard Lewis of the AFV Branch had arranged for their 2nd and 3rd echelon transport to be provided by surplus vehicles of No. 1 GHQ Company of the Royal Army Service Corps (RASC), on this unit's arrival. The AFV Branch made their way north from Le Mans to the concentration area west of Arras on 1st October, joining the rest of GHQ at Wanquetin, with Frederick Hotblack taking the opportunity to greet all the companies of 4 RTR at their billets the subsequent day.

It would be the turn of A.V. Golding to visit 4 RTR on 3rd October, along with the 13th/18th Hussars, who were one of the divisional cavalry regiments operating Light Tank Mk. VI B's. Golding was investigating the lack of dedicated No. 10 ammunition belt boxes for the two units' Vickers machine guns, which had been specifically designed for AFV use. This box was packed with an "expendable" stripless linen belt containing 250 rounds, in which the pockets for holding the individual rounds were separated by stitching. This was in contrast to the non-expendable type of belt in which the rounds were separated by brass strips riveted into the linen. The lack of No. 10 boxes was a problem as the belt boxes issued to the infantry would not fit the belt box carrier for the guns in either tank. On 5th October both Golding and William Blagden visited the 1st Corps Ammunition Park at Écoust-Saint-Mein, ten miles (15 km) southeast of Arras, where they found two types of belt box stocked for tank use. The first of these was labelled "For Ground Use", although its belt and ammunition were marked as "suitable for A.F.V. use if removed from lining", the "lining" being the box itself. This box had been issued to the RAC units, although as its label suggested it would not fit in the belt box carriers provided with tank mountings. The AFV Branch's diary recounted that:

> The other liner was suitable for Tanks Lt.M.VIB, but fouled the feed spool and bracket of the M.G. mounting in the 'I' Tank. This was removed from one of the latter tanks and 250 rds fired successfully at various elevations. Unit was instructed to remove feed spools and brackets from remainder of Tanks.

The feed spool on the Infantry Tank Mk. I was attached to a bracket on the left hand side of the mounting, and helped align the belt between the belt box and the feed block of the gun. The No. 10 AFV belt box had a unique shape as its top corner was "cut away" and fitted with an angled flap which could be hinged



This picture of the tanks of 4 RTR on the journey to Arras provides a good view of the inlet and outlet louvres. Note the rectangular locking slots on the inlet louvre meshes for fixing the blanking plates, and the empty bracket for the aerial base. The access hatch for the radiator filler can be seen just below the gun. (IWM O576)

open to allow the gun to be fed while the main part of the lid remained closed. This in turn kept the belt securely packed while the tank was traversing uneven ground. However if a normally shaped box was fitted in the belt box carrier, its corner would foul the feed spool, whose location was only permitted by the unique shape of the No. 10 belt box. The AFV Branch addressed the 'Q' branch at GHQ about the shortage of the No. 10 box, the latter promising to investigate the supply position back home. The task of the BEF at this time was to occupy the Lille sector of the French frontier with Belgium, and as part of this effort 4 RTR were to move to the "forward area" in the vicinity of the small town of Attiches, approximately 25 miles (40 km) northeast of Arras and just south of Lille. Here, they were to assist the 4th Infantry Division, which was the reserve division of 2nd Corps, to hold the nearby hill feature of Mons-en-Pévèle, and to assist in any counter-attack should it be lost. After a number of delays 4 RTR moved to Attiches on 15th October, and on the following day Frederick Hotblack visited the 4th Division's Headquarters to discuss their role, the AFV Branch's diary relaying that:

> The Div have not completed recces for their roles but do not anticipate any particular difficulties with regard to Tanks. Brig. stressed that Mk. I Infantry Tanks were effective against hostile infantry but not against tanks and furthermore that tanks had a far greater chance of being effective if used at once against hostile infantry than they would be say 24 hours later when the hostile A.Tk defence would be organized.

Hotblack then consulted the headquarters of 2nd Corps before calling in on 4 RTR themselves, remarking that "Their move to ATTICHES has been carried out satisfactorily and it appeared that the slow pace on the pavé roads had resulted in much less wear to tracks than on previous moves on pavé, carried out at normal pace." *Pavé* roads were roads that were surfaced with stone paving cut in small blocks, the "previous moves" mentioned by Hotblack presumably having occurred in England. The unit had two groups of reserve personnel, these being their reserve tank crews and their immediate or "first" reinforcements, the latter having remained in the rear area at Acq and Écoivres to be called forward in the event of casualties. At this time the four divisions of the BEF were only just beginning to settle in, these being the 1st and 2nd infantry divisions of 1st Corps and the 3rd and 4th infantry divisions of 2nd Corps, and a surprise attack by the Germans was considered a real possibility. 4 RTR themselves were still under the command of GHQ, with 2nd Corps being responsible for their administrative (*i.e.* supply) needs, and one of the reasons for the delay in their move to Attiches was that the line to be occupied by the 4th Division could not be settled until sufficient anti-tank defences had been dug. On 17th October the AFV Branch issued a memorandum to the 1st and 2nd Corps dealing with the "Conservation of Tracks", this conceding that the urgent need to commence training was compromised by the uncertain availability of spares, most notably of tracks and sprockets, which were the parts most subject to premature wear. It was accordingly upheld that:

> This places an unavoidable limitation upon the use of vehicles for training. Corps should ensure that the maximum use is made of every mile run. It is specially wished to avoid the necessity of imposing any restriction upon the miles which can be expended upon training, but it is pointed out that if vehicle casualties are high, due to training with troops, it may be necessary to limit the number of miles which can be run for that purpose.

A number of suggestions were therefore made in order to minimise the mileage to be employed in training, these being that:

> (i). Complete exercises, *e.g.*, to seize and hold an obstacle, should be considered only. The operation can be considered in phases with consequent saving of mileage.
>
> (ii). The ground selected should be as near as possible to billets.
>
> (iii). Schemes should be carefully prepared with the object of making the most of the miles run.
>
> (iv). Full use should be made of demonstrations by one sub-unit to the other sub-units.
>
> (v). It will often be possible to avoid waste mileage by carrying out an exercise, in the first instance as a T.E.W.T.

A "scheme" in this instance was another term for an exercise, usually at the smaller battalion, squadron or troop level, while a TEWT was a Tactical Exercise Without Troops, this basically being a classroom exercise. A conference was held on wireless training at GHQ's operations ('G') branch on 18th October, following representations by Frederick Hotblack to the Signal Officer in Chief, Brigadier Ralph Chenivix-Trench, to rescind the requirement for wireless silence in the case of armoured divisions. The restrictions on wireless use resulted from the misplaced fear that the Germans had a surfeit of direction finding equipment that could locate Allied units by their wireless signals, this in turn encouraging the BEF to pursue a policy of prioritising communication by line cable. In the case of armoured

units, this had restricted any wireless practice to the short range No. 11 set, which did not adversely affect the Infantry Tank Mk. I's of 4 RTR, although Hotblack urged Chenevix-Trench that units also needed to practice with their longer range No. 9 sets, as well as conduct a greater range of wireless training generally. Richard Lewis attended the conference on behalf of the AFV Branch, where he was informed that:

> There were not enough frequencies to enable issue of a complete duplicate set of frequencies for training, so keeping operational frequencies free. This was due to lack of co-ordination in the design of our sets with those used by the French.

This indicated that the frequencies available on British and French sets tended to overlap, although this was not necessarily a disadvantage. It was also suggested that "If a general release was made, units should not use R/T or W/T nearer than 10 miles [15 km] to their normal billets", as "This to confuse German Direction Finding." R/T in this instance was Radio Telephony, which was the use of wireless for voice messaging, while W/T was Wireless Telegraphy, the use of wireless to send signal messages. The perceived problem with keeping wireless practice away from billets is that it contradicted the need to minimise track wear, the AFV Branch stating that "As far as tracked vehicles were concerned, this would put unwarranted mileage on tracks which were being conserved for an operation." It was also apparent that the Signals branch were not yet prepared to authorise practice with longer range sets, as "No training frequencies were available for No. 9 Sets, which could not therefore be used for training the Rear Link of Div Cav Regts — as important a point from the A.F.V. point of view as from that of the Army at large." Within the Divisional Cavalry units, a "rear link" wireless set was carried in a single tank in each squadron headquarters to communicate with the regimental headquarters (RHQ), and in a tank in the RHQ in order to communicate back to divisional headquarters. This issue was not quite as pertinent to 4 RTR, as the 1st Army Tank Brigade headquarters had yet to arrive in France, and so they did not have an ultimate "rear" to link to. The AFV Branch then consulted GHQ's senior staff officer, the GSO I, Lieutenant-Colonel Robert Bridgeman, their diary recalling that:

> Subsequently S.D. (Lord Bridgeman) expressed agreement with the view that possibly the risk from jamming in operations was less than the risk of going into action with untrained personnel. He also agreed to take up the general question of the position when more units of Armoured Corps came to France. This in view of fact that Chief Sigs G.H.Q. representative at the Conference had said that the ether was 'already too small to hold the French and ourselves'.

Regarding the 1st Army Tank Brigade's headquarters back in England, on 20th October this was finally given a permanent commander in the form of Giffard Le Quesne Martel's former Assistant Director of Mechanization, Douglas Pratt, with John Caunter relinquishing his temporary command. On 21st October Richard Lewis visited the headquarters of 2nd Corps to meet their senior staff officer, Brigadier Vyvyan Pope, who was the Brigadier General Staff (BGS). He discussed the role of 4 RTR with Pope, as well as the arrangement of the local anti-tank defences, including any pre-prepared gaps in them for 4 RTR to pass through when counter-attacking. He then called on 4 RTR themselves at Attiches, where he noticed that the roads were being badly "cut up" by the infantry and other troops working on the anti-tank defences and other frontier fortifications. He further attested that "When Attiches is inspected from the air, from the camouflage point of view this damage cannot fail to stand out." This comment was another reflection of the almost obsessive focus on security, as was the following statement that:

> 4 R.Tanks have an ingenious device to provide crossings on line of R. MARCQ. It was agreed that this should be examined and approved by 2 Corps before it was put into use in view of risk of location by enemy agents.

This device was a wooden cradle, the River Marque (Marcq) being a tributary to the canalised River Deûle that flowed through Lille, the source of the Marque being at Mons-en-Pévèle. It was also recorded that "Instructions for the destruction of our machines if likely to fall into enemy hands have now been given to S.D. for issue", with "SD" being GHQ's Staff Duties branch. The following day Frederick Hotblack inspected 4 RTR's camouflage efforts, as:

> Brig.A.F.V. flew, with camouflage expert G.H.Q., over lying up places of 4 R.Tanks at ATTICHES. The result was satisfactory as even when location of tanks in orchards etc. was known, they were hard to pick up at about 2,300 ft [700 m].
>
> Some general trampling of grass could be detected (this was seen in many other orchards) and one tank was seen in the open, apparently being worked on.

As well as camouflage, 4 RTR had also been busy designing identification marks for their tanks, with Richard Lewis calling on the unit on 24th October to determine the final details of the markings. This was a job that the AFV Branch's diary mockingly claimed he should already have carried out in his previous role in the Staff Duties branch of the War Office. It was decided that AFV's within the BEF would be marked with a white square with sides of nine inches (23 cm), these to be applied to the Infantry tanks, Light tanks, carriers and armoured cars. In the case of the Infantry Tank Mk. I, four such squares were to be applied, with one on the front, one on each side, and one on the rear. In the case of the front square, this was to be situated in the centre of the nose plate, although when the tarpaulin tank cover was being carried, a nine inch (23 cm) square metal plate was also to be carried beneath the lashings for the tarpaulin. For the side squares, these were to be painted on the blanking plates (previously known as "blanking boards") for the ventilation inlet louvres, the square to be to the rear of the fixing handle on the plate. In case either of these plates was removed, another white square was to be painted on the hull behind it. For the rear of the tank, the raised plate on the hinged engine cover was to be painted white on its upper surface and also on its edges, this plate being centrally located and having been raised in order to clear the induction pipe from the air cleaner to the carburettor. 4 RTR had also been busy in improving the anti-tank defences in the Attiches area, providing fifty men each day to assist in their construction.

There was still a certain amount of controversy regarding the counter-attacking role of 4 RTR, with a proposal from Frederick Hotblack to put them under the command of the 4th Division having been rejected by the BEF's Deputy Chief of Staff (DCGS), Major-General Philip Neame. Hotblack went to see the 4th Division on 26th October, their commander, Major-General Dudley Johnson, telling him that he was not able to make any written plans for a counter-attack, although he was liaising with Alec Gatehouse, the commander of 4 RTR on the defence of the bridges across the Deûle. Hotblack then moved on to 2nd Corps headquarters to discuss the scope of future operations with its commander, Lieutenant-General Alan Brooke, with Neame also being present. Finally, Hotblack saw Alec Gatehouse to discuss methods of enabling his tanks to cross friendly anti-tank obstacles at secretly prepared places, the AFV Branch mentioning that "The latter wanted to use wooden cradles instead of fascines to put in the MARCQ stream for this purpose, also camouflage to make a partly dug obstacle look like a fully developed one." Meanwhile, far to the

Crew maintenance being carried out on the powertrain of an Infantry Tank Mk. I of 4 RTR in Acq on 19th October 1939. This picture gives a particularly good view of how the roof of the engine compartment folded open, giving excellent access to the fuel system and the engine itself. (IWM 0742)

south, a mysterious consignment had been chanced upon by the Royal Army Ordnance Corps's No. 1 Base Ordnance Depot at Nantes on the Loire river. The diary for the depot reprised on 2nd November that:

> O.O. [*i.e.* Ordnance Officer] Docks reported that 10 'COULTER' were landed ex 'BARON CARNEGIE' (S.B.11) and these were lying on the quayside not claimed by anyone. No mention of items in Bills of Lading. Inspected stores: they appear to be special appliances being heavy steel frames on built up steel wheels. Not identified as Ordnance Stores: G.H.Q. wired for disposal instructions. This is an example of stores being shipped without identification papers or advice direct to consignees.

These were of course ten Fowler mine ploughs for the Infantry Tank Mk. I, which were now colloquially referred to as *coulter ploughs*. No. 1 BOD was the main ordnance and spares depot for supplying the BEF, although its distance from the forward area around Arras was 360 miles (580 km) in order to minimise the possibility of air attack. William Blagden went to see 4 RTR on 4th November to inspect an Infantry Tank Mk. I that had been fitted with a more powerful 0.5-in. (12.7 mm) Vickers Machine Gun in place of the standard 0.303-in. (7.7 mm), this being an attempt to upgrade the tank's firepower in order for it to take on light armour. While Blagden was there, he was asked to broach with the AFV Branch the possibility of equipping fifteen of the regiment's tanks with this weapon. Five days later, on 9th November A.V. Golding would attend a trial of the 0.5-in. Vickers machine gun installation at Attiches. As the particular 0.5-in. gun obtained had been configured for a Light Tank Mk. VI B, it had been fitted with a right hand feed block in contrast to the left hand feed of the 0.303-in. normally fitted in the A11. However the belt box carrier was positioned on the left hand side of the A11 gun mounting, so a new feed tray had been mocked up that passed the ammunition belt under the gun in order for it to be fed into the feed block from the right. The trial revealed that the feed path could be improved, with the Royal Army Ordance Corps (RAOC) representatives present agreeing to manufacture the final design of feed tray once they had received a modified mock-up. On the Light Tank Mk. VI B the 0.5-in. gun was fitted with its distinctive conical flash eliminator, although this had to be removed to allow the gun to be manipulated into the mounting within the smaller turret of the Infantry

Side view of the same tank as in the photograph on the previous page, the turret being orientated rearwards to allow quick access to the driver's compartment. All the external stowage and tools are present and correct, while also visible is the driver's horn, just inboard of the nearside headlamp. (IWM 0746)

Tank Mk. I. The loss of this item did not overly perturb Alec Gatehouse, with the AFV Branch divulging that "O.C. [*i.e.* Officer Commanding] 4 R.Tanks accepted the muzzle flash as he considered it of paramount importance to have some hitting power against enemy A.F.Vs in the Bn." Also examined during the trial was the performance of the spent cartridge ejection tube, which was located directly under the barrel and ejected the cartridge cases through a slot in the bottom of the external armoured gun shroud.

On 11th November William Blagden and A.V. Golding visited the 'Q' Branch at GHQ to discuss means of hastening the delivery of replacement tanks in the field, their proposal being that these be held in pools at Ordnance Field Parks, which were RAOC companies that held stores and vehicle spares. As such, when a damaged or defective tank (or other AFV) had to be sent to an Army Field Workshop (AFW) for repair, the unit which deposited the tank would request a time for the repair to be completed. If the AFW could not meet this time, then the driver of the tank could be sent to the requisite Ordnance Field Park to request a new one, this reducing the time that the unit would be understrength. The Quartermaster's branch agreed to this arrangement in principle, provided that maintenance drivers for the tanks could be provided by the RAOC. Three days later the AFV Branch would be visited by Major Lugard of MGO3, this being the MGO branch that oversaw small arms requirements, who informed them that he could provide four 0.5-in. Vickers guns for issue to 4 RTR, these complementing twelve spare guns that were now with the BEF. On 20th November A.V. Golding met with the BEF's two senior RAOC representatives, these being the Director of Ordnance Services (DOS), Brigadier Arthur Gibson, and the Principal Ordnance Mechanical Engineer (POME), Brigadier John White. Gibson informed him that the transference of spares for 4 RTR from 1st Corps to 2nd Corps was being pursued, although the War Office had turned down his proposal to hold replacement tanks for 4 RTR within a GHQ Ordnance Field Park. This would not deter the AFV Branch, who would continue to pursue the matter with the Staff Duties directorate in London.

In the meantime limited development of the Infantry Tank Mk. I was continuing at the Mechanization Experimental Establishment so as to eliminate any remaining vices, one of which pertained to its engine clutch. As we have seen, MEE Report A107 of 8th July had intimated that a new "Don-Flex" clutch disc was being trialled in order to eliminate the problems in gear changing that were being experienced with the standard Ford Clutch. This new clutch disc was manufactured by Small and Parkes Ltd. of Manchester, and featured fabric facings which were joined to the disc by compressed cork plugs rather than by the usual metal rivets, these providing a continuous friction face without the need for rivet recesses. The disc had been fitted to production Infantry Tank Mk. I T1724, the trial having been conducted over six months between 18th April and 18th October. MEE Report A178 of 20th November detailed that the clutch had been run for a total of 652 miles (1050 km), of which 267 (430 km) had been on the road and 385 (620 km) across country, and that "Throughout the course of this trial, no trouble whatsoever has been experienced with the Don-Flex clutch disc." During the course of the trial, around a hundred stops and restarts had been performed on the Miles Hill No. 4 slope, of gradient 1 in 2.46, and "After 250 miles [400 km], the clutch was stripped for examination, but the condition was so good, that no measurements were considered necessary." The clutch was stripped again at the end of the trial, it being concluded that "The Don-Flex clutch disc has proved to be satisfactory in use, and its condition after 650 miles [1050 km] is very good." In their Minute A3164 of 22nd November the Mechanization Board stated that "The Committee recommend that Don-Flex clutch discs, type DF/71 with rigid centre, be specified for all future Tanks, Infantry, Mark I, and for early replacements in existing vehicles." At nearby Aldershot, 7 RTR had been experimenting with the best means of combining the Infantry Mk. II tank with the Mk. I, their experience prompting an official decree to the 1st Army Tank Brigade from the DDSD(AFV) at the War Office, Brigadier Arthur Kenchington, on 18th November. Kenchington, who was in charge of the SD7 branch, recapitulated that:

> With reference to Military Training Pamphlet No. 22 of 1939, Part III, Section 1, I am directed to inform you that the rate of production of equipment necessitated, as a temporary measure, organising regular army tank battalions into companies in which Mark I and Mark II 'I' tanks were mixed. Experience has shown that there are tactical disadvantages in the organisation of companies of five sections of one Mark II and two Mark I 'I' Tanks.

What the tactical disadvantages of the mixed section were was not revealed, although the A12 was considerably faster than the A11, and had greater obstacle crossing capacity, so the most likely explanation was that the larger tank would have frequently left the smaller one behind. Kenchington continued by stipulating that:

> I am to say that 7th and 8th Battalions Royal Tank Regiment will therefore organise and train on the basis of companies of two sections of three Mark II and three sections of 3 Mark I 'I' tanks. Battalions of army tank brigades other than 1st Army Tank

Brigade will organise and train on the normal basis of companies and sections consisting entirely of Mark II or Mark III 'I' tanks.

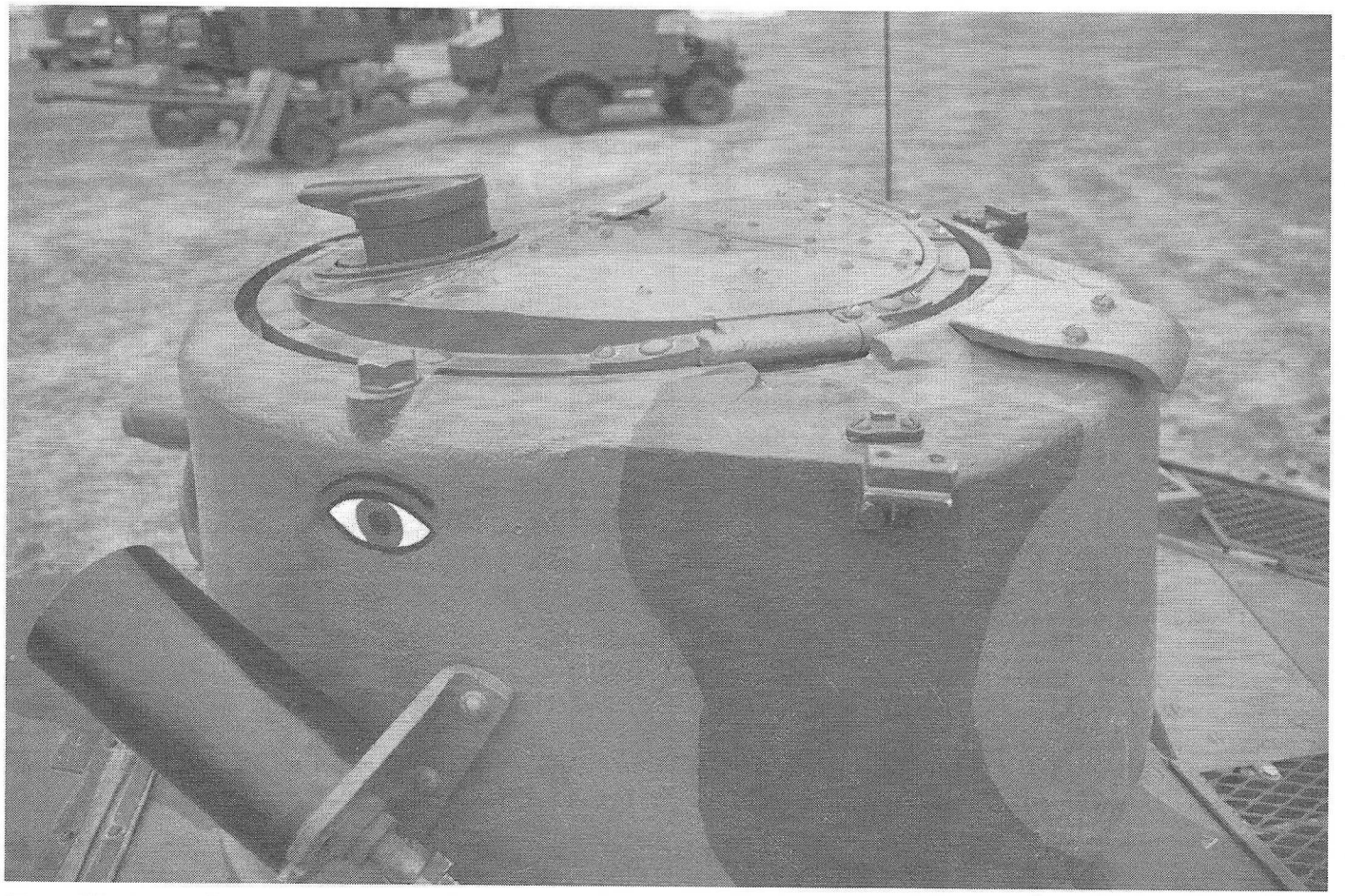
On 25th November No. 1 Base Ordnance Depot at Nantes would report that the ten "Coulters" that it had alighted on at the docks had now been identified as anti-mine devices, with their missing items having been located at the nearby Royal Engineers' park. After cabling the War Office they had been informed that these were intended for 4 RTR, and so they had arranged for the Royal Engineers to send the mine ploughs on to the Advanced Ordnance Depot (AOD) at Arras. The AFV Branch at GHQ had also been contacted, these having arranged the reception of the equipment at the AOD. As November was drawing to a close, it was becoming clear that production of the Infantry Tank Mk. II was not likely to move beyond a trickle, with six such tanks having been completed during the month to give a total of twelve since production had commenced in September. Production of the Infantry Tank Mk. I was also relatively sedate, with twelve being accepted during November, the total output now standing at 98. This was a concern, as Frederick Hotblack was expecting the 1st Army Tank Brigade to be in France by March 1940 with at least two battalions of the more modern infantry tanks, and an Army Tank Division to be in the field by September 1940, this comprising three Army tank brigades, with at least five of its nine battalions being operational. In contrast, 7 RTR at Aldershot had only recorded receiving their first three A12's during November. However, the AFV Branch had received a telegram from the War Office (presumably SD7) informing them that it might be possible for the British to buy the two man Hotchkiss H35 light infantry tank, this being known by the French Army as a *char léger*. This featured cast armour of 40 mm thickness and a short barrelled low velocity 37 mm main gun in a one man turret, and a six cylinder air-cooled petrol engine capable of giving a top speed of approximately 17 mph (27 km/h). An improved model, the H39, had also been developed, this boasting a more powerful 120 hp (90 kW) engine that was capable of propelling the vehicle at 22 mph (35 km/h). However, the most important feature of these machines was that unlike the equivalent British tanks they were already available in volume, with the H39 currently being produced at a rate of approximately sixty per month. As a consequence, on 25th November Frederick Hotblack, Richard Lewis and A.V. Golding visited an unidentified French unit to inspect an example of the Hotchkiss, although they came away unimpressed, as:

> This type of tank was found to be little suited to shelled area in Northern France as it is short and with a low idler wheel in front. It would be difficult for British personnel to become efficient in it as it is small and contains French weapons (2·7 c.m. [*sic*] gun and machine gun) which must be loaded and fired by the tank commander.

The three men then moved on to Paris to meet Sir Albert Stern and the members of his Special Vehicle Development Committee (SVDC), who had arrived from the recently formed Ministry of Supply in order to study the "fortress tanks" that were being developed by the French Ministry of Armament. These were to be assault tanks suitable for attacking the main German defensive line, the *Westwall*, which was known to the Allies as the Siegfried Line and which consisted of numerous anti-tank barriers and concrete emplacements. The Ministry of Supply had been instituted on 24th August, absorbing the MGO and DGMP directorates from the War Office and combining them with the expertise of civilian industrialists, the intention being to facilitate the dramatic boost in armaments production that was now deemed essential. Stern's committee were visiting France in pursuit of their brief to develop a "shelled area" tank capable of operating in the assault role in what were expected to be the challenging ground conditions of northern France and Flanders. On 27th November The AFV Branch's diary conveyed that:

> The above Committee with Brig., A.F.V. [Hotblack], G.S.O.I., A.F.V. [Lewis], and D.A.D.M.(E) [Golding] visited in the morning the Tank Establishment at VERSAILLES where the existing types of French Tanks were seen running in wet and muddy conditions. The sub-soil was, however, gravel and the terrain did not therefore present either of the two main difficulties in Tank movement, *i.e.*:-
>
> (a). Marsh, which presents inadequate bearing surface.
>
> (b). Heavy clay soil which when wet, clogs the tracks and suspension.
>
> Both types of soil are made more difficult by shelling.

The "tank establishment" at Versailles was the French Army's *École de Chars* (Tank School) in the Satory quartier of Versailles, which included a test course for armoured vehicles. In the afternoon the party visited the *Atelier de Construction de Rueil* (ARL), where they inspected outline drawings of two projects for a *Char de Forteresse*. One of these would almost certainly have been this firm's own design, the ARL *Tracteur C*, which featured an unusually long hull of over twelve metres that would permit the crossing of trenches up to seven metres wide, the vehicle being armoured up to 120 mm and expected to weigh an



View of the turret of preserved Infantry Tank Mk. I T3447 at The Tank Museum, Bovington. At the rear of the turret can be seen the two supports for the hatch doors, as well as the armoured cover for the steam outlets of the coolant header tank for the Vickers 0.303-in. machine gun. The boss just above the "Chinese eye" symbol is for the turret lifting eye, there being an equivalent on the other side of the turret, it being fitted with a non-standard bolt in this instance. Notice the groove around the turret hatch assembly, which is a ventilating air inlet. (Craig Moore)

extraordinary 120 tonnes. A turret carrying a 47mm gun was positioned towards the front of the hull, the hull itself being separable into a pair of detached modules. It was likely that the second project that the AFV Branch and the SVDC committee examined was the Tracteur C's main rival, the equally extraordinary FCM F1, although it was regretted that "Neither the existing French heavy tank (CHAR B) nor the later projects offered an early solution to War Office requirements." On the following day, 28th November, Hotblack verbally reported on the investigation into the French tanks to Philip Neame, the DCGS, while A.V. Golding further pursued the potential adoption of the Hotchkiss tank, as:

> D.A.D.M.(E) visited Hotchkiss works with Col. Watson of the Mechanization Board and discussed with the firm's Manager (Mr. Ainsworth) a proposed 3-man tank lay-out as previously asked for by the D. of M. The proposed modified suspension, 12 bogie wheels instead of 6, and longer pitched track with an outrigged rear idler for the 1939 Hotchkiss were discussed. The assembly of the Char B at Satory was then viewed with the Stern Committee and at a subsequent meeting it was agreed that the production was complicated.

W.D. Watson was of course the Deputy Superintendent of Design, while Henry Mann Ainsworth, the Director and General Manager of Hotchkiss was one of the team of Englishmen who largely controlled the firm, which was based in Saint-Denis in northern Paris, and indeed it was this English connection that had helped facilitate the contacts with the War Office. However, the British were seeking a substantial redesign of the H39, the mooted doubling of the bogie wheels suggesting the introduction of paired rather than single wheels, so as to reduce ground pressure and thus improve flotation on soft mud. The propounded "3-man tank layout" indicated the desire for a two man turret, which though considered less than ideal, was still an improvement on the one man standard hitherto preferred by the French.

The Char B1 *bis* was the main French heavy tank, this being larger and heavier even than the A12, featuring armour up to 60 mm thick and being armed with a 47 mm gun in a single man turret and a 75 mm howitzer mounted at the front of the hull. This machine was to equip the new mixed infantry and armoured *divisions cuirassées*, the first of which was about to be formed, but despite its intimidating appearance it would once again fail to impress, as on 29th November:

> D.A.D.M.(E) visited VINCENNES with Col. Watson and the Stern Committee. A Char B was to be demonstrated over the hill ground there but broke down and was unable to perform. A Hotchkiss 1939 and S.O.M.U.A. were seen performing instead. The former was held up on the 35° bank due to track slip on the muddy clay. The ground was thick with mud which was not nearly so sticky as the Flanders variety. There was also firm bottom.

The Somua S35 was a medium tank of around 19 tons that equipped the *divisions légères mécaniques* of the French Cavalry, mounting a single man turret with 47 mm gun adapted from that fitted to the Char B1. During the middle of November, Frederick Hotblack had arranged with 4 RTR to conduct trials against various anti-tank obstacles, and to mock-up a trench-crossing device that could be carried by the Infantry Tank Mk. I. In response, the regiment conducted a demonstration on 2nd December, this being witnessed by Hotblack and William Blagden, as well as representatives from 1st and 2nd Corps, with a report being subsequently issued by the AFV Branch. Two basic obstacles were to be tested, the first of these being the French *champ de rails* (field of rails), which consisted of three rows of vertical steel rails, with each rail weighing 90 lbs. (40 kg) and measuring nine feet (2.7 m) long, these being buried in the ground such that the exposed portion projected three to four feet (about a metre) above it. The second obstacle to be assessed was a standard anti-tank ditch, which was to be assailed by the improvised methods that Frederick Hotblack had asked 4 RTR to devise. A single Infantry Tank Mk. I was assigned to tackle the champ de rails, it being recorded that:

> The tank succeeded in bending over some of the rails owing to the softness of the ground and climbing on top of the others. The ones that it climbed on top of were driven into the ground by dead weight. After repeated assaults the tank got through the first two rows and was checked on the third. A heavier and faster tank would certainly have got through, and the Mk 1 would have done better if it had not been slowed down by the very heavy soil of the field in which the obstacle was situated.

Given that the A11 was a far smaller machine than the main German medium tanks, the Panzerkampfwagen III and Panzerkampfwagen IV, this was a disquieting result from the defensive point of view. A further test was then conducted on a variation of the champ de rails, which comprised a road block consisting of two rows of nine foot (2.7 m) long steel channels set into the ground in concrete sockets, such that the projecting portion was four feet (1.2 m) above the ground. Once again a single Infantry Tank Mk. I was dispatched against the obstacle, it being observed that:

> The tank easily bore down the channel sections and passed over them. It had to bend 3 in each row. Those in the front row were fixed with their webs right angles to, and those in the rear row with their webs parallel to, the line of the road. In the latter case the sections twisted through a right angle in order to yield about the weakest axis.

The webs of the channels in this instance were five inches (13 cm) long, while the two flanges were two-and-a-half inches (6 cm) long, such that the flanges offered weaker resistance to bending. After reaching the other side of the obstacle, the tank was made to reverse back over it, with the bent channel section now pointing forwards toward it, while also being inclined at an upward angle. It was reckoned that:

> This was found to be much more difficult and several attempts were required. During it's [*sic*] struggles the tank was held up on several occasions by the ends of the bogie leaf springs catching against the rails, both on the inside and outside of the tracks. There was no tending for the channels to snap off.

A number of conclusions were derived from these demonstrations, including that railway sections were more easily snapped off than structural steel ones (such as channels), and that broad flange joists were probably the best kind of section to employ, these being parallel to the direction of attack thus making them more difficult to bend. In the case of rail obstacles, it was urged that they should be formed in a manner that made them difficult to drive into the ground, and if they were set in concrete it was better not to bring the concrete up to ground level. This would have been because if the concrete were at ground level any bending would have been induced at the point where the rail or channel projected above the concrete, where it would be unsupported. It had

Rear view of preserved Infantry Tank Mk. I T3447 showing the shackle-type combined towing and lifting eyes, the Ern-Lake tower jack, and the bin for the jacking blocks. Note how on this first production batch machine the transmission hatch is hinged at the bottom for rearward opening, its handles being arranged horizontally. (Craig Moore)

of course been discovered that "Obstacles are more effective if the rails are pointing in the direction of the enemy, as they are not bent over backwards so easily", while it was also advised that "The belly plates of tanks should be strong enough to resist perforation by the end of a rail, when the entire weight of the tank is resting on it." Following the difficult experience of reversing the Infantry Tank Mk. I back over the bent channel sections, it was asserted that "All salient features of the bogie system should be faired off as much as possible. This is also necessary for the successful negotiation of wire obstacles." It should be noted that the bogies of the Infantry Tank Mk. II were protected by an external armoured skirt, which not only defended the suspension from external attack, but also prevented damage from anti-tank obstacles.

The second obstruction to be traversed, which was a standard anti-tank ditch, was to be done so by four different experimental methods, the first of these being via a tank bridge that was manoeuvred into position on the Fowler mine plough of an appropriately equipped A11 (referred to in the report as an Infantry Tank Mk. IA, indicating that it was from the second production batch). This bridge was merely a timber mock-up, with rope tackle being manually employed to lower the plough (and thus the bridge) into position in place of the power take-off mechanism, which would presumably be employed if the project was pursued further. The report attested that as the bridge was lowered and the angle of the supporting rope became more acute, its wooden structure disintegrated under the strain. It was therefore commented that "It is evident that a small derrick or King post would be required to improve the angle of the launching rope and reduce the tension." A king post is the central supporting post below the apex of a roof in a roof truss, the principle invoked here being that the tank would have to mount a tall post at the front of the hull, or on the mine plough, with the support rope for the bridge running over the top of it before connecting with the far end of the bridge. The second ditch-crossing method employed another mock-up bridge, this one being carried on the back of the tank as it was driven into the ditch. From here, the bridge was manually lifted up so that it rested on the far bank, it being observed that "The underside of the bridge just cleared the top of the turret, which was not removed." This was adjudged to have been

a success, as "Had the bridge been real, a crossing would have been possible." A five foot (1.5 m) diameter brushwood fascine constituted the third means of traversing the anti-tank ditch, this being laid in position manually before the approach of the tank. This was a well-proven method from the previous war that "made the crossing an easy matter." The final device tried was the most complex to employ, this constituting twin gangways constructed from channel sections that were bolted together, which were carried to the gap on two tanks and placed in position by a detachment of men. The aforementioned tanks were driven into the ditch side by side, with a gap being left between them, the gangways being carried on the rear track guards of each tank, on the side that faced the other tank. The detachment of men were then driven up in a carrier, and on debussing worked between the two tanks to lift the two gangways into position across the gap, connecting them together by the transverse tie-rods that were provided for this purpose. The bridge thus formed was crossed immediately by a third Infantry Tank Mk. I, and then by the first two tanks after they had backed themselves out of the ditch. Overall, it was concluded that:

> The most satisfactory methods of effecting a crossing appeared to be those using fascines, or using a tank as a bridge. In the latter case it should not be necessary to provide a complete road; a run-way for each track will suffice. Any adjusting gear must be made simple and must be controllable from within the tank.

On 4th December Frederick Hotblack visited the French General Staff (the Grand Quartier Général or GQG) to meet *l'inspecteur général des chars* (Inspector-General of Tanks), *général de division* Louis Keller, with Hotblack's precis of the conversation outlining that:

> Although the French were better prepared for this particular war than any other nation, they were also caught at a period of change and expansion; they have moreover gone through the usual changes necessitated by the great improvement in the numbers and penetration of the German anti-tank guns: thus their best tank, the Char B, was designed as a 20 ton machine with 40 m.m. of armour; it now weighs 30 tons and had 70 m.m. of armour.

In fact, the updated model of the Char B1, the B1 *bis*, only had a maximum 60 mm of armour, the 70 mm standard being reserved for yet another updated model, the B1 *ter*, which had yet to commence production.

View of the transmission compartment on second production batch Infantry Tank Mk. I T8106 at the The Tank Museum. Notice how the hatch for the transmission compartment has been modified to accommodate the winch drive for the Fowler mine plough. The hinges are now at the top of the hatch for forward opening, with the handles being reorientated vertically. (Craig Moore)

The increase in armour had necessitated a similar increase in engine power to maintain performance, with the Brigadier AFV relaying that "the engine has been 'hotted up' but it is otherwise the same and is in the opinion of the Inspector, inadequate." A new design of heavy tank was under consideration, which Hotblack thought bore a "great resemblance to the War Office specification for a shelled area tank." This was to be based on the basic Char B design, with a turret mounted anti-tank gun and a hull mounted howitzer, although it was to be longer, have 80 mm of armour and weigh 50 tons. It was also to have its front track horns and idler wheels raised in height, these having been kept low on the Char B series in order to assist the peripheral vision of the driver, at the cost of the tank's ability to climb slopes and overcome vertical objects. Keller himself expressed the view that the most important quality of a tank was good performance in difficult terrain, with armour coming second. Hotblack stated that French tactics had originally envisaged the Char B1 tanks operating a good distance ahead of any advancing infantry, of up to around 1000 yards (1 km), although he acknowledged that "the French views are now more similar to our own." In this latter respect the French had conceived of a combined tank and infantry attack, preceded by an artillery barrage, with the Char B1's advancing at a density of one tank per 25 to 50 yards (~25 – 50 m). Behind these "The smaller tanks and infantry are to follow as closely as possible but it is feared that in many conditions of terrain the small tanks (Hotchkiss and Renault) may be delayed and will have to dig themselves through obstacles." The Renault tank referred to here was the R35, which was another *char léger* that was built to the same specification as the Hotchkiss H35, having a two man crew and the same one-man APX turret. *Général* Keller confessed that the *chars légers* were the product of a shortage of time, money and material, although:

> All were 'infantry tanks' in the British sense. They would be 'mixed' for any particular operation in accordance with the situation. But the Char B was also capable of 'independent' (cruiser) action in going. It was an '*en tout cas*' [*i.e.* multi-purpose] machine.

Indeed, the main task of the *divisions cuirassées* was to carry on the momentum of an attack when the initial assault by infantry and infantry tanks had exhausted itself. Although the *chars légers* were limited to good ground conditions, production of them was to continue as they could be turned out in relatively high numbers. However a larger *char léger* of proportions similar to the British Infantry Tank Mk. II was being contemplated, this having an armour standard of 60 mm and weighing twenty tons. In general, the conversation with Keller demonstrated that the French idea of the kind of tank warfare that could be expected against the Germans in northern France was aligned with that of the British. There was thus an anticipation of relatively static warfare in poor soil conditions made worse by shell fire, in which the premium tank had excellent cross country performance and the heavy armour necessary to escort the infantry onto the objective, with limited exploitation being undertaken afterwards. Indeed these would be just such the conditions that E.M.C. Clarke had deprecated for tank employment back in 1933. Such a role necessitated a long track base for maintaining traction on the ground and for crossing both trenches and shell holes, while the most ambitious projects that both nations were contemplating involved particularly large, elongated tanks with numerous bogie wheels. These were also tanks that harked back to the previous war, and Hotblack even suggested that as far as terrain covering performance was concerned, there was a need for a new iteration of the rhomboid Mk. V tank of 1918. The French also concurred with the British on a number of ancillary points, with *général* Keller advancing that for their 37 mm and 47 mm anti-tank weapons the armour piercing characteristics were paramount, at the expense of any bursting (*i.e.* explosive) effect. This was an advocacy of solid shot rounds, which the British were at this time switching to for their 2 pounder anti-tank gun. For the French, any explosive effect was to be supplied by their hull mounted weapons, which were mainly to be deployed against enemy fortifications.

Hotblack also relayed that *l'inspecteur général* "does not think that pilot models are desirable in war, since they take up a great deal of time, and the faults in the first machine to be produced can be put right in later ones". This echoed the current British practice of ordering tanks into production "off the drawing board", although it went a stage further, as the British were still producing pilot models (*i.e.* prototypes) for development trials while production was being organised. One area where the British diverged markedly from the French was in their conception of how tank turrets should be laid out. Keller admitted that the standard one-man French tank turret gave the commander "*un métier horrible*", although the requirement for even one extra man appears to have been accepted rather grudgingly, this being feasible only "if the centre of gravity of the whole machine could be kept low and if there was no sacrifice of armour or weapons." This was of course far behind the standard British requirement for a three-man turret. However, it should be borne in mind that one of the primary drivers for this more generous turret crew allocation was the British infatuation with the ability to fire on the move, which they imagined would be a particularly effective battle winning capability. The limitations of their turrets were however forcing the French to take a more realistic approach to tank gunnery,

View of the offside support bracket for the track adjuster assembly on preserved second production batch tank T8106. The headlamp was now mounted on this bracket, as was the stand for the driver's rearview mirror, which in this instance is folded downwards. The bulb for the lamp has been removed for blackout conditions on British roads. The patch below the name Demon *represents gas detection paint. (Craig Moore).*

it being expounded that "Their latest training involves close co-operation between gunner and driver so as to enable the driver to stop for just enough time for the gunner to fire one round." Whereas the British were utilising wireless sets that could be operated on both "send" and "receive", Keller appeared to favour a more hierarchical approach, with only company commanders being able or allowed to transmit messages, and all other tanks of the unit being capable or permitted to receive only. This was obviously going to tactically restrict the French armour, although it was to some extent practically necessitated by their small turrets, in which unobtrusive receive-only sets would be ergonomically more suitable. Concerning the fortress tanks, Keller expressed his satisfaction with replicating the arrangement that currently existed in the Char B1, with the turret mounting an anti-tank gun and the heavier calibre gun being mounted in the hull front. However, the French general staff (GQG) wanted to mount the heavy guns in the turret, with the *Ministre de l'Armement* (minister for armaments), Raoul Dautry, having confided to Hotblack that this was proving to be technically challenging.

Frederick Hotblack received orders on 5th December that he should return to England on the 10th to accept a promotion to Major-General and assume command of the 2nd Armoured Division, which at this time only existed on paper. He was to be superseded by Brigadier Justice Tilly, although in the event Tilly's arrival was delayed until 12th December, with Hotblack departing on the 14th. In the meantime, 4 RTR were visited on 6th December by the commander of the 1st Army Tank Brigade, Douglas Pratt, and his brigade major, Captain Bernard Cracroft, for the battalion's inspection by His Majesty the King, George VI. While these events had been ongoing, A.V. Golding had spent the period from the 10th to the 13th December at No. 1 Base Ordnance Depot at Nantes on behalf of the Maintenance section of GHQ's Quartermasters branch. Here, he was assisting the POME, Brigadier John White, compile a list of 'A' vehicle spares required to be sent forward from No. 1 BOD to the Advanced Ordnance Depot at Arras. However, it was discovered on arrival that No. 1 BOD had been sending on large consignments of spares that had arrived from England directly on to the AOD, the contents of which had not been recorded, and so it was not possible for Golding to tabulate what additional items might be required. He therefore consoled himself with a general audit of the depot, contending that the great distance between No. 1 BOD and the forward area at Arras rendered its organisational efficiency rather pointless, as:

> [On] the M.T. [*i.e.* Mechanical Transport] side both depot and workshops was well organised within the limits imposed of insufficient suitable space available, great dispersion and hopelessly long lines of communication forward. Thus, though the M.T. side can clear a demand within 24 hours of receiving it, a letter or demand is still taking from eight to ten days to reach them. If, as is sometimes the case with impressed vehicles, an indent has to be queried a further delay of from sixteen to twenty days may elapse before a reply is received. It appears therefore that because of faulty communications an excellent base organisation, keenly served, is largely wasted when it comes to service of the Army.

Indeed, the impracticality of servicing the BEF from Nantes had now been recognised, as:

> It is understood that present arrangements are for two Base Ordnance Depots each capable of dealing with *six* Divisions and each allotted to half the force. When the Second Depot (No. 2) opens at Le Havre it will serve the Field Force and the No. 1 Depot will switch over to service the L of C [Lines of Communication] units only. This may mean transfer of all A.F.V. and much of M.T. Stores to No. 2 Depot to be handled by a fresh staff out from home.

The Lines of Communication units mentioned here would mostly consist of third line transport units of the RASC, the move to Le Havre halving the distance for spares to reach the AOD at Arras to approximately 180 miles (290 km). As such, once it was opened No. 2 BOD at Le Havre would undertake the bulk of supporting the forward area, via the main transport node at Rouen, while No. 1 BOD would mainly support the rear areas. The current policy regarding the Advanced Ordnance Depot at Arras was that this would only supply its own workshop (the AOW), and not the various Ordnance Field Parks for servicing the field formations, which were to be supplied directly by the BOD's. Golding considered this to be unsatisfactory, as:

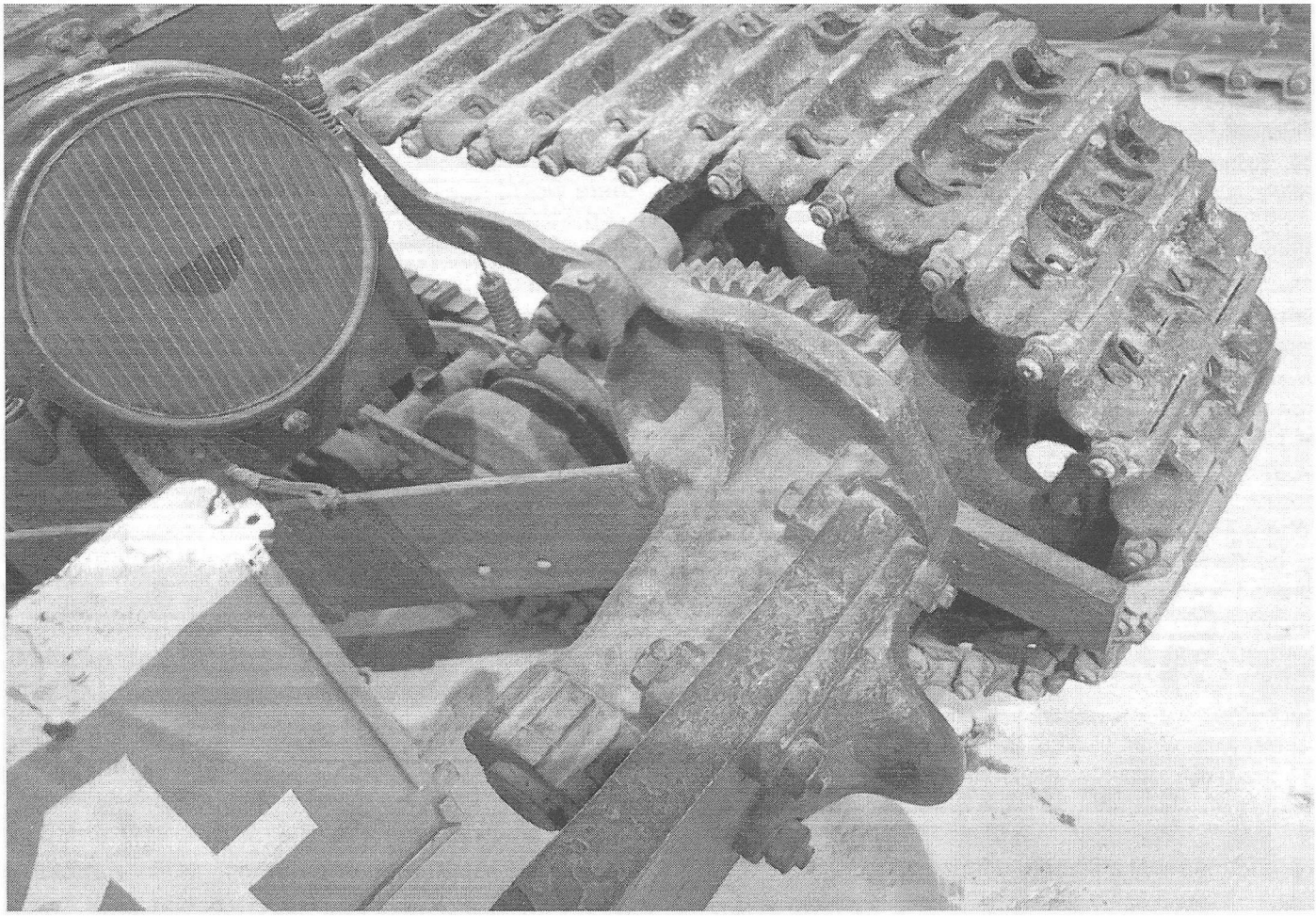
> From A.F.V. [Branch's] point of view it would be desirable, especially in view of the present delay in satisfying indents even if spares are available, to use the A.O.D. to speed up the supply of stores to keep both vehicles and their equipment in action. It appears desirable to consider maintaining a supply of floating spares (for feeding O.F.P's) at A.O.D. in excess of the minimum requirements if communications to the rear are severed for a period.

The allotment of spares to the Base Ordnance Depots from the United Kingdom was another vexed

issue, as these were coordinated by the RAOC's Central Ordnance Depot (COD) at Chilwell, near Nottingham. However, the priority of the Ministry of Supply was to boost the production of new tanks rather than spares, with Golding arguing that "It is of importance to A.F.V. [Branch] that a balance on this is struck, for, great though the need is for new vehicles, failures of supply of important spares overseas might easily immobilise many vehicles here." It had been suggested to Golding that the extra link in the procurement chain represented by the Ministry of Supply added another three weeks to Chilwell's requests for spares from the manufacturing firms, while the only requests for spares that were given first priority were those demanded by the BEF's GHQ. This meant that standard parts demands submitted by units had no particular priority unless the AFV Branch made a special case for them, and if the spares had to be sent directly from home, the process for obtaining them was potentially labyrinthine. Golding therefore commented that:

> It was thought that with all the numbers of new vehicles coming over there might be some delay in initial supply of spares. From A.F.V. [Branch's] point of view any delay in these spares particularly A.12 and A.13. would be extremely serious and we need an assurance from home that ample supplies of spares will be forthcoming in time.

He did note however that from February 1940 the BOD's were expecting to institute a demand-led system in which the depots themselves made bulk requests for spares based on scales of anticipated need, although these scales would need to be compiled beforehand, most likely by the AFV Branch. Another problem in procuring spares had resulted from a lack of parts lists, which made the identification of requisite parts more difficult and resulted in vague or inaccurate indents. Golding impressed that these should be supplied at one copy per unit, per Ordnance Field Park, and per Base Ordnance Depot, because:



View of the nearside track adjusting mechanism on preserved tank T8016. Particularly visible is the lug for engaging the track adjuster tool. Note the shroud fitted within the headlamp for blackout conditions on British roads, the internal reflector also having been painted black. The blackout arrangements for the two headlamps would be reversed on Continental roads. (Craig Moore)

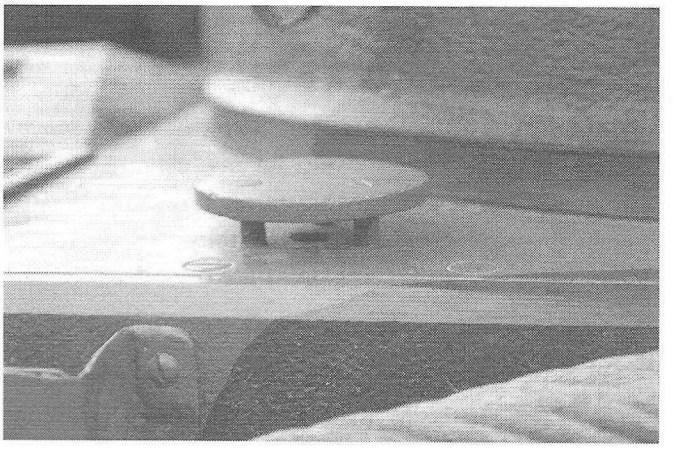
> Without them both units and depots are largely in the dark and serious delays in supply are inevitable. An instance is the Infantry Tank Mk. I. It should be emphasized that an incomplete advance copy is better that none and it is essential that they should be made available at an early date.

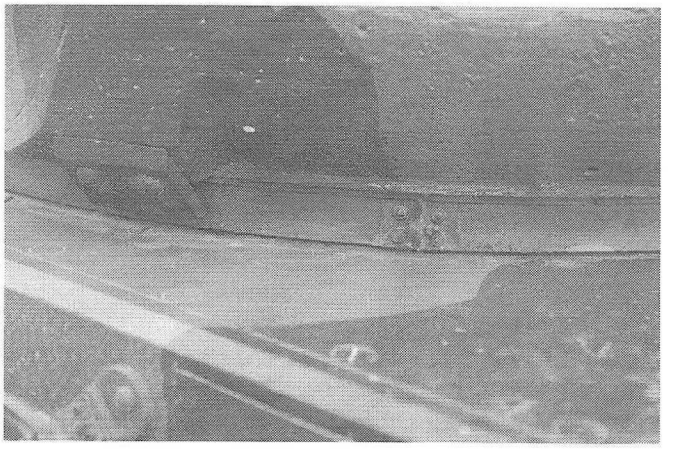
The Ministry of Supply had allotted 15% of tank production to spares, with the BEF adopting the principle that most repairs would be conducted at the Advance Ordnance Workshop using spares sent forward. As such, tanks would only be sent back from the front for repairs if they were seriously damaged, with heavy repairs being conducted by the Base Ordnance Workshop at Nantes (No. 2 BOW) and no tanks being sent back to the United Kingdom for repair unless it was unavoidable. However, on enquiring as to the status of the workshops at Nantes, Golding's findings were somewhat disquieting, as:

> It was understood that these were already full up with repairs for L of C and that of the two workshops available only one has railway access, and this one is on an island in the river. It appears a suitable moment for A.F.V. [Branch] to ask D.O.S. [*i.e.* Brigadier Arthur Gibson] for an assurance that he will be able to undertake major repairs of the heavy Infantry Mk. II tanks after March, 1940.

In one of his first initiatives as Brigadier AFV, Justice Tilly would pay a visit to Vyvyan Pope, the BGS of 2nd Corps, on 16th December, to discuss the latter's return to England to take command of the 1st Heavy Armoured Brigade of the 1st Armoured Division, his position within 2nd Corps being taken by Brigadier Neil Ritchie. Within the United Kingdom, the War Cabinet of Prime Minister Neville Chamberlain had set up a Military Co-ordination Committee in which the three ministers representing the services, and their three chiefs of staff, could coordinate strategic policy for presentation to the Cabinet. This committee was chaired by the Minister for Co-ordination of Defence, Ernle Chatfield (1st Baron Chatfield), and considered the equipment production position as part of its purview. At the 8th meeting of the committee, on 18th December, the Minister of Supply, Leslie Burgin stated that the present production rate of Infantry tanks was 22 per month, this being something of an overestimate as only 18 had been produced during November, with the output rate expected to rise to 60 per month by September 1940. Indeed a recent committee paper on Infantry tanks, MC(39)23 of 13th December, had indicated that only 103 such tanks had been accepted by the 30th November, this in fact being an underestimate, the true figure being 110. However, this paper had also stated that another 67 Infantry tanks were expected to be completed by the end of March 1940, against a requirement of 492 by this date, of which 300 were to be allocated to the BEF. This was despite the fact that no less than nine firms had been contracted to produce Infantry tanks, and it was now clear that production was not going to come close to meeting demand. Burgin did however have a longer term remedy, as:

> It was hoped, however, to expand production by the introduction of a simpler design of tank, based on the French Hotchkiss. This tank was now in production in France, where one factory was producing three per day. It was a lighter vehicle, and only had one man in the turret. The British General Staff required a tank with two men in the turret, and staff were at present hard at work designing a modified vehicle, based on the French tank, which would fulfil the General Staff's requirements.





***(above)** Detail view of the aperture cover for the cable from the No.11 Wireless Set to the aerial base on the offside hull. **(below)** Detail view of the turret boss that housed the exit aperture for the Bowden cables for the 4-in. smoke dischargers, this being protected by a bolted plate.* *(both: Craig Moore)*

It should be noted that as well as a larger turret, the ideal British requirement included a doubling of the number of bogie wheels, although it is not clear whether the redesign work referred to by Burgin was being undertaken by Hotchkiss in France or at the Mechanization Board at Woolwich. The plans for the adoption of the Hotchkiss were potentially ambitious, with the minister laying out that:

> A new range of factories could be brought into production of these vehicles but production could not start before January, 1941. It was then hoped to turn out 50 per month, rising to 80 per month later in that year.

At this juncture the First Lord of the Admiralty, Winston Churchill, intervened by hazarding "whether the acceptance of the French tank without alteration would accelerate its production." If it were, he suggested that the General Staff might accept it unmodified "in view of the very serious deficiency which present plans could not make good." The senior War Office representative present, Major-General Laurence Carr, the Assistant Chief of the General Staff (ACIGS), responded in the affirmative, stating that:

> the General Staff would certainly accept the French tank in these circumstances. They had enquired whether an alteration could be made to the tank so as to accommodate the extra man, and, if so, whether production would thereby be delayed. They certainly would not press for the alteration if delay would result.

In this he was backed up by Brigadier John Crawford, who was now the Deputy Director-General of Mechanization within the Ministry of Supply, who hazarded that "some acceleration would undoubtedly result from accepting the French tank as it stood." The meeting therefore agreed that "the French Hotchkiss tank should be put into production in this country, without modification, on a scale sufficiently large to make up the deficiency of infantry tanks, at the earliest possible moment." They moreover concurred that "designs for a modified infantry tank, based on the French Hotchkiss tank, but containing two men in the turret, should proceed with a view to its introduction into the programme, if thought advisable, at a later stage." From this, Leslie Burgin was invited to produce a revised paper on the production of both existing and modified versions of the Hotchkiss tank up to the end of August 1942. However, as the production of Cruiser tanks was in a similarly deficient state, Churchill's personal assistant, Professor Frederick Lindemann, noted that the characteristics of the Hotchkiss might also lend it to this role. This was because it was similarly armed to the Cruiser, and at 13 tons had a similar weight, although it was somewhat slower and had compensating heavier armour. Laurence Carr in response stated that "the General Staff would be prepared to consider such a substitution, though he was not able to pronounce definitely on it at such short notice." He did however point out that the main objections to using the Hotchkiss in the Cruiser role was its one man turret and lack of a wireless, as "It was necessary for a cruiser tank, which would be operating over great distances, to be equipped with wireless, and it was hard for one man to command the tank, to fire guns, and to work the wireless." Carr nonetheless conceded that "it might be sound policy to accept certain disabilities, if by no other means the necessary number could be obtained". This evidently pleased Churchill, who submitted that "We would, in any case, have to set up a large capacity for the Hotchkiss tank under the decisions already taken, and it ought to be an easier matter to increase this capacity, than to find additional firms to produce our cruiser tank." Leslie Burgin was accordingly invited to incorporate Hotchkiss Cruiser production in his revised paper, this initiative presenting the possibility of the British not only fielding a single tank for two major roles, but also one that was common to the French. This promised to make British tank output substantially more efficient, as at this time production was in the process of being diffused between three marks of Infantry tank and six marks of Cruiser. Indeed, eleven production firms had already been contracted to produce Cruiser tanks, and the Ministry of Supply's Director-General of Tanks and Transport (DGTT), Peter Bennett, was looking for further additional capacity.

On 20th December Justice Tilly and Richard Lewis visited 4 RTR at their new location of Fiervillers, sixty miles (100 km) southwest of Attiches, to attend an exercise (or "scheme") that the unit were undertaking the following day with the 9th Infantry Brigade of 3rd Division. Both Tilly and Lewis identified two problems with this initiative, the first of these being the familiar one of track mileage, it being desirable to minimise the wear of tracks and sprockets in case tanks were immediately needed for action. The second issue was the fact that the exercise in question was being undertaken a long distance away from the training ground originally selected for 4 RTR, the AFV Branch's diary musing that "It also seems wrong to treat 4 R Tanks as a travelling circus while other troops settle down for the winter." The two day exercise was to consist of a counter-attack along a 1300 yard (1.2 km) front to re-establish a bridgehead over the River Canche between Boubers-sur-Canche and Frévent, in which two companies of infantry were to be supported by two companies of Infantry tanks. The first echelon (*i.e.* company) of tanks were to advance supported

by two platoons of machine gun carriers, one on each flank, these being followed by the first echelon of infantry who were to slightly precede the second echelon of tanks until they met opposition. A number of comments on the exercise were jotted down by Tilly on 23rd December, having observed the scheme from the left flank. He explained that the first tank echelon had moved off 300 to 500 yards (~300–500m) ahead of the infantry in the wake of an artillery barrage, the tanks being accompanied by the machine gun carriers on both flanks. The BAFV then noted that:

> This Echelon advanced at Infantry pace, each tank marching straight to its front, and in no instance seen was any attempt made by the tanks to quarter the ground and seek out enemy M.Gs. Had enemy M.Gs been present it is probable they would have lain low until the barrage and the leading echelon of tanks had passed and then come to 'life again' which might have entailed severe casualties for 1st wave of infantry.

"Quartering" is a hunting term in which a gundog searches out an area of ground to flush out game birds for shooting, this implying that the first echelon of tanks had simply passively rolled forwards. Tilly added that "It is difficult to jink and maintain correct forward movement when the barrage is not represented", this implying that the artillery barrage that had preceded the exercise was a notional one, and had not been put into physical effect. It was then asserted that:

> It is suggested that the barrage should proceed at infantry pace, but that the 1st wave of tanks should use all the speed they possess to quarter the ground in rear of the barrage. A certain number of M.Gs and L.As [*i.e.* light artillery] will be dealt with but some are bound to be missed and it therefore appears that when possible 1st tank wave should be in greater depth.

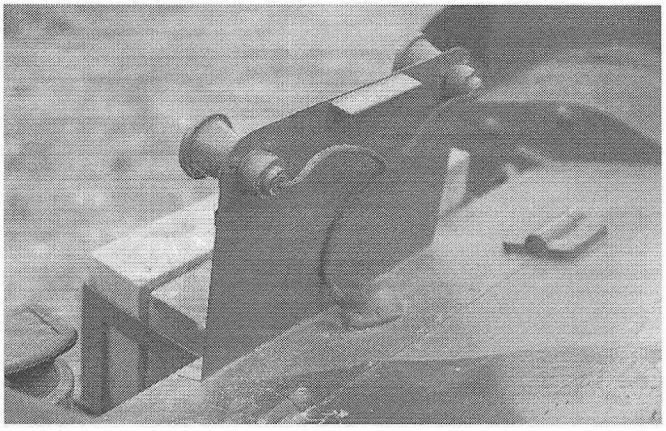
Tilly then noted that if too large a gap was left between the first echelon of tanks and the first echelon of infantry, then any enemy machine guns that had been missed by the barrage and the tanks would then open up on the following infantry. The large gap would also enable the enemy to direct their defensive fire over the tanks and at the infantry. On the other hand, if the gap was too small the opposite problem would occur, with the infantry potentially falling victim to overshoots from the fire directed at the tanks. He therefore estimated that the optimum distance between tanks and infantry was 300 yards (~300 m), although this figure would vary on a case-by-case basis. Regarding the machine gun carriers, Tilly had observed that:

> On the left of the attack, where I was, the M.G. Carriers advanced on the flanks of the first tank wave and appeared to be rather too close up, which would have made it difficult for them to provide covering fire for the tanks against the A.Tk guns, as they would have been under the same fire as the tanks. On the right flank this did not arise and I understand that the Carriers were in exactly the right position.

He had also noticed that the second echelon of tanks had advanced on the left flank slightly ahead of the second wave of infantry, thereby making it difficult for the infantry to attract the tanks' attention if they were obstructed by unlocated enemy machine guns. It was accordingly posited that the second wave of tanks should advance sufficiently far behind the infantry so they could receive instructions from them and manoeuvre accordingly. Tilly had observed that both tank echelons had eventually halted on a forward (*i.e.* downward facing) slope in view of the enemy anti-tank guns, this being an obvious error. He was also unimpressed with the performance of the Infantry Tank Mk. I, submitting that:

> I would stress the fact that the present 'I' Tank in use (Matilda) is not suited for 'I' work in that it is very slow, has little trench crossing capacity, lacks on A.Tk weapon, and with a crew of only two (Gunner and Driver) it is exceedingly difficult for the commander to keep the gun firing, keep touch with the situation and direct the driver at the same time. It is probable that the improved characteristics of the Mk. II 4 man tank will materially alter the tactical outlook.

In response to the exercise, Tilly was preparing a technical paper "in amplification" of Military Training



Detail view of the rear vehicle registration mark (VRM) plate in the original production position, showing the cabling for the rear headlamps. *(Craig Moore)*

Pamphlet No. 22 Part III, which dealt with the employment of infantry tanks as part of the tactical handling of army tank battalions. It was this document upon which the exercise by the 9th Infantry Battalion and 4 RTR had been based on, although MTP No. 22 Part III had emphasized that the first wave of infantry keep as close to the first wave of tanks as possible, with Tilly now advocating a larger gap. He was to base his paper on the presumed greater flexibility offered by the Infantry Tank Mk. II, proffering that:

> It is suggested that the first wave of infantry should be carried in Armoured Carriers and deposited as necessary to mop up and consolidate. This principle was accepted in 1918 and the Carriers actually built, but if the idea is accepted it may be some time before the Carriers are available.

The previous carriers referred to in this statement were the Mk. IX tanks, of which 34 had been built out of an order for 200, most of these being completed after the end of the Great War. This comment was further evidence of the convergence of both the British and French on the efficacy of the assault techniques that had been pioneered during the later stages of that war. On 24th December Tilly wrote to the Staff Duties brand of GHQ on the ongoing matter of the Hotchkiss tanks. A.V. Golding had received a request by demi-official (DO) letter from the Ministry of Supply to make preliminary enquiries for the cash purchase of two of the updated H39 model of the Hotchkiss, complete with weapons and spares. This request appears to have been prompted by the fact that Golding was shortly to adopt a new role as liaison officer to the French Ministry of Armaments, this allowing him to commence the process of sourcing the tanks before financial sanction was sought from the Treasury. However, Tilly was unwilling to follow this particular route, proffering that any purchasing activity should be put on an official basis from the start, and be pursued via the correct channels. It was also the case that the Brigadier AFV was sceptical as to the utility of the Hotchkiss as he expressed that "I am not satisfied that the Hotchkiss is the type of machine we need, except in the last resort, and I have not been informed that that situation has yet been reached." He also noted that neither Frederick Hotblack nor himself had yet seen a convincing demonstration of its performance, as:

Tanks of 4 RTR exercising with the infantry of the Coldstream Guards at Couin on 12th January 1940. The tank at the front is fully opened up, the two quadrant doors of the turret hatch resting on their supports. These tanks are likely from 'C' Company whose commander, Major B.A. Holford-Walker can be seen in the balaclava on the far right. (IWM F2140)

> For some time my predecessor and myself have been seeking an opportunity to see this tank demonstrated over heavy and difficult going, the demonstration at Versailles having been quite inconclusive. So far the weather has been either too wet or too hard. Perhaps I may succeed in January.

He additionally argued that any trials or demonstrations conducted with the Hotchkiss were better off being undertaken in France with either borrowed or hired machines, as:

> I have in Lt. Col. Gatehouse of 4. R. Tanks an ex-commanding officer of the M.E.E. who is fully competent to undertake these trials. There should be no difficulty in accommodating observers from home or in conducting the trials as long as the military situation remains unchanged. A great advantage would be that the machines would then be tested in more nearly the conditions in which they will have to operate.

Brigadier Tilly visited a conference held by the 3rd Infantry Division on 27th December, the subject of the meeting being the training that this formation had conducted up to that date, including the exercise that had been undertaken six days previously. Among the attendees were the divisional commander, Major-General Bernard Law Montgomery, the commander of the 9th Infantry Brigade, Brigadier William Robb, and Alec Gatehouse of 4 RTR. Montgomery had gleaned four lessons from the exercises undertaken so far, two of these being stricter traffic discipline in the approach march to the area of operations, and stricter discipline with regard to radio and telegraph communication. He also highlighted the need to ensure that troops were entered into battle with the best possible preparation, and the necessity for there to be a standardised doctrine for tank-infantry cooperation. Concerning such a doctrine, he advanced that there were two operational circumstances to be considered, the first being one in which the local conditions necessitated the leading infantry moving in the closest possible cooperation with the leading tanks, and the second where the local conditions made it desirable for the tanks to operate a bound ahead. In the first scenario, Montgomery emphasized that the tanks and infantry were a team that must practice together, and that the scope and dispositions of the tanks and infantry were a matter for the relevant battalion commanders. He also pointed out that one of the duties of the infantry was to help direct the blinder tanks, this necessitating intercommunication between the tanks and the infantry, with the location of the infantry platoon commander relative to the commander of the allotted tank section being crucial. In the second scenario, in which the tanks would operate a bound ahead, Montgomery posited that the artillery barrage should be tailored to suit the leading tanks, and as this necessitated the tanks quartering the ground for the benefit of the infantry, this needed to be factored into the arrangement of the barrage, the inference being that the progress of the tanks would necessarily be slower. This scenario also permitted carriers to form the second wave in order to provide covering fire through the leading tanks, with the leading infantry moving slightly ahead of the second wave of tanks. The AFV Branch would be visited on 28th December by Lieutenant-Colonel Raymond Briggs of the War Office's Directorate of Military Training, and on the subsequent evening the branch's diary would record that:

> Paper on the *Organization of the Maintenance and Repair of A.F.V.s in the Field* completed and commented upon by Lt-Col BRIGGS to the effect that it reproduced the organization of the last war which had been proved. Since it was written without more than very general knowledge of the 1916 – 18 system the result is worthy of note.

Briggs oversaw the training policy at the AFV Driving and Maintenance School at Bovington and the Gunnery School at Lulworth, this comment once again demonstrating how the experience of the previous war was gaining an increasing influence on British thinking. On 29th December the AFV Branch issued a set of training instructions for RAC units within the BEF, this advocating a number of sensible measures for Infantry tanks that were nonetheless far beyond the current capabilities of 4 RTR, as:

> Training will be directed to the study of the employment of tanks in mass. Exercises should be designed within a framework which employs several Brigades and should include exercises in which our tanks [*sic*] forces will be operating in conjunction with those of our ally.

This vision depended on the build up not only of a large number of Army tanks, but also of the forces available in general, as:

> In considering the employment of tanks in mass in this theatre, it must be remembered that the assembly of large numbers of troops of all arms will be necessary. The scale of the resulting operations will be such as to limit the choice of action open to lower commanders. The main problem confronting

commanders of lower formations will therefore be to adapt their courses of action to a general plan covering a large area and which may place certain lower formation[s] and individual unit[s] in situations which, viewed by themselves, may be unfavourable.

The latter point was underlined by the principle that:

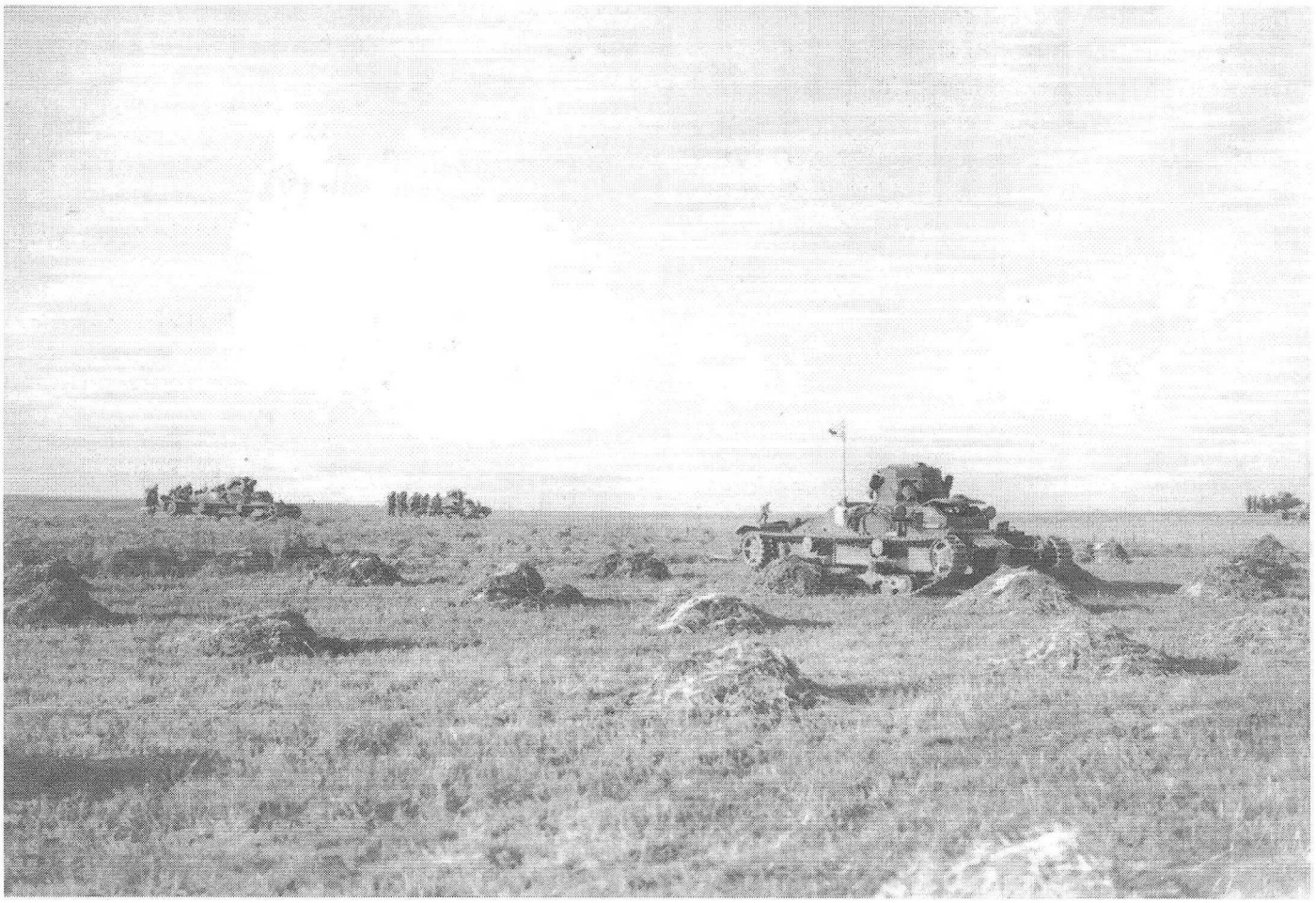
The tendency to concentrate on the local plan to the exclusion of the main plan must be combated. The adaptation of the small plan to the larger one is more important than the production of the ideal local solution. Exercises will be framed to emphasise this aspect of large scale war.

These passages reveal that it was understood by Frederick Hotblack that the effectiveness of the 1st Army Tank Brigade was dependent on the extent to which it could develop an intimate relationship with the other combat arms of the BEF, the most important of which were the infantry and the artillery, as well as with the French. Such an approach was of course limited in the present by the fact that only one of the brigade's battalions was currently in France. Another limitation was indicated in the subsequent statement that:

Special attention will be devoted to Tank V Tank action, both in the encounter form which might arise during the progress of an attack, and in the deliberate form which might occur if an Army Tank Battalion were required to support the defence.

An attached report by the GQG emphasized of this type of action that "It is a *gun-fight*: only the shell can give a decisive result. The bad shot is at the mercy of the good shot." This of course precluded the Infantry Tank Mk. I, the AFV Branch underscoring the need for the Infantry Tank Mk. II to be available in these instances. It was at this time assumed that operations would commence before sufficient Infantry Tank Mk. II's were available to produce a "homogenous" organisation within the 1st Army Tank Brigade, and so any exercises to simulate tank versus tank fighting would assume a "mixed" organisation of Mk. I and Mk. II infantry tanks. It was however submitted that "Exercises based on

Another Infantry Tank Mk. I pulled up on the side of the road during the exercise with the Coldstream Guards on 12th January 1940. Clearly visible is the hot air deflector shield just behind the turret, which helped to prevent warm air from the engine compartment ventilation outlet louvres being sucked back in via the inlet louvres. The small identification plate on the bin for the jacking blocks is likely related to the exercise itself. (IWM F2139)



*Tanks of 4 RTR on exercise with the 2nd Battalion of the North Staffordshire Regiment in the area of Souastre and Hébuterne on 11th January 1940. In this instance a section of infantry appears to have been allocated to each tank, with the exception of T3444 (*Devil*), in the foreground.* (IWM F2103)

homogenous Mk. II battalions will also be carried out", this being an ambitious statement as only 24 such tanks had left the factory prior to Christmans. Nonetheless, 4 RTR's commander, Alec Gatehouse, was tasked with developing a mixed organisation based on having twenty Infantry Tank Mk. II's available. With regard to the tank battle, the French had made the notable statement that "The advantage lies with *stationary and masked formations against moving ones*" this contradicting the British emphasis on tanks being capable of firing on the move. The French also pronounced that "*Maximum fire power* should be obtained" and so "Therefore one should get to the fight with all arms able to act simultaneously". This therefore advocated that the principle for dealing with tanks was to concentrate all available heavy calibre weapons, rather than to favour weapons of a particular type. The British themselves concurred, with the AFV Branch stating that the GQG report "confirms our experience from Tank V Tank training in peace". In terms of individual training, the AFV Branch maintained that this should be concentrated on tank maintenance, as:

> The fighting efficiency of an armoured unit depends in the first instance upon the mechanical conditions of the vehicles. Vehicles can only be kept in a state of sound mechanical condition by regular inspection and constant maintenance. These are the direct responsibilities of all commanders up to and including the Commanding officer of the unit. Both require study and training.

The commanders in question here were individual tank commanders, troop commanders and then squadron commanders, the AFV Branch asserting that "Commanding Officers will ensure that all officers and senior N.C.Os [*i.e.* Non-commissioned Officers] are instructed and practised in the inspection of vehicles." A reminder was given that the unit had a senior RAOC officer, the Ordnance Mechanical Engineer (OME) to assist them in this purpose. The AFV Branch warned against the abuse of tanks in regard to their automotive performance, as:

> The vehicle as designed will give a maximum performance within the limits of its component parts. It is not intended that the vehicle should be required to give this maximum performance except in exceptional circumstances. Training should aim at impressing on all ranks the need to drive their vehicles well within the limit of performance. Without this training, and a developed sense of 'vehicle mastership', the unit as a whole cannot be kept at a high state of mechanical efficiency.

This was essentially an appeal for units to practice road moves as slowly and carefully as possible in order to reduce the wear and tear on their vehicles, the "exceptional circumstances" when the full performance of tanks could be exploited only occurring during particularly intensive phases of active operations. This advice was supported by the experience of 4 RTR in their move to Attiches, which had been successfully achieved due to the modest pace employed, the AFV Branch impressing that "Good maintenance, therefore, implies the avoidance of damage as much as it implies the detection and correction of faults before they have gone too far." When it came to the early stages of driver training, it was urged that this should be conducted on the minimum number of vehicles, to which any wear and tear would be restricted. These machines could then be submitted for overhaul at the end of the training period, with reserve tanks being issued in their stead. The components most subject to wear were the tracks and their drive sprockets, it being set down that:

> Where possible, low mileage tracks and sprockets will be taken off and carefully secured together for subsequent refitting after training. They will be replaced by part-worn tracks and sprockets obtained from D.A.D.O.Ss, which will be run until the tracks commence to jump the sprockets. *On no account* will part-worn tracks be fitted to sprockets already on the machines.

The DADOS's were Deputy Assistant Directors of Ordnance Supply, who where the RAOC officers in charge of forward field parks and depots. These training instructions demonstrated that the AFV Branch had a sound understanding of both the operational and tactical employment of tanks, although their prescriptions were undermined by the meagre resources available to the BEF. On 3rd January 1940 Robert Bridgeman of GHQ's Staff Directorate called in at the AFV Branch to discuss the best means to combine infantry and tank training so as to arrive at a common doctrine within the BEF. Bridgeman and Tilly agreed a three stage procedure, of which the first was for the Staff Directorate to issue a letter to all the formations in the BEF instructing them to experimentally adopt the methods that had been developed by the 3rd Division. For the second stage, Tilly would complete his paper augmenting Military Training Pamphlet No. 22 Part III, and submit it for consideration by the BEF's Commander-in-Chief, Lord Gort. Finally, if Gort was in concord with Tilly's paper, he would chair a conference of Corps commanders and order them to adopt the proposed system of tank-infantry cooperation. This would then stay in force until any operational experience prompted its revision. As an immediate measure, Bridgeman would present the three stage procedure to the DCGS, Philip Neame, in order to gain permission to issue the letter that comprised stage one, while the Staff Duties directorate would also attempt to discuss the proposals with the War Office back home. Also on this date Richard Lewis attended a conference held by GHQ's Operations ('G') Branch, where he found out that the Dannert wire that had been sourced by the BEF could be cut with a basic wire cutter, this alarming Neame and provoking him to order that tests be undertaken by 4 RTR. The AFV Branch were accordingly instructed to arrange an evaluation in concert with BEF's Engineer-in-Chief, Major-General Ridley Pakenham-Walsh, it being communicated that "It is considered to be highly dangerous to allow B.E.F. to expect a performance from this wire which it will not give." GHQ would relocate from Wanquetin to nearby Arras on 6th January 1940, while over the 8th and 9th January Justice Tilly would attend a conference with the 1st Infantry Division at Souastre, fifteen miles (25 km) east of Fienvillers, this being followed by a scheme conducted by the Grenadier Guards and 4 RTR. For these events he was accompanied by his new junior staff officer, Captain Carr, who on 10th January would join William Blagden at a trial of a Hotchkiss tank cooperating with infantry, although the units involved in this event were not named.

The 11th January would see Tilly and Richard Lewis watch another exercise by the 1st Division, this time pairing 4 RTR with the 2nd Battalion of the North Staffordshire Regiment, these simulating an attack on Essarts-les-Bucquoy. A subsequent discussion with the 1st Division's commander, Major-General Harold Alexander, as well as the visiting commander of the 1st Canadian Division, Major-General Andrew McNaughton, led to the consensus that "there was a necessity for the leading echelon of tanks to consist of two waves in front of the infantry." This echoed Tilly's comments of 23rd December, in which he had argued that the first echelon of tanks ought to have greater depth in order to facilitate better quartering of the ground ahead of the first echelon of infantry. The following day Tilly was joined by Francis Arkwright in witnessing yet another scheme, with 4 RTR on this occasion working with the Cold-stream Guards. Meanwhile

in London the 4th Meeting of the Military Co-ordination Committee had been held on 10th January, with the Hotchkiss tank once again being discussed, as Lord Chatfield enquired whether the War Office and Ministry of Supply had further investigated its potential as a substitute Infantry or Cruiser tank. Sir James Grigg, the Under Secretary of State for War at the War Office responded with the familiar objection to the one-man turret, although he conceded that "If, however, we could obtain say 200 Hotchkiss tanks within the next 3 – 6 months the General Staff were willing to accept them." However, if it were to take nine to twelve months to source them, Grigg saw no benefit in their acceptance, the meeting minutes recording the response of the Minister of Supply as follows:

> MR. BURGIN said that there was no hope of obtaining 200 Hotchkiss tanks within the next 6 months. Monsieur Dautry was coming to London the following week to discuss a scheme whereby we would supply steel castings and a certain number of machine-hours and man-hours, and in return the French would complete and deliver them to us.

Raoul Dautry was the *Ministre de l'Armement* in Paris, his proposal generating a degree of cynicism within the Ministry of Supply with George Turner, the Second Secretary, later alleging that the willingness of the French to offer the Hotchkiss was a ruse to relocate a portion of their production to Britain to lessen its vulnerability. As such, Turner believed that the French had been exaggerating their tank production in order to elicit British interest. In the meantime limited development work on the Infantry Tank Mk. I was continuing, with the MEE at Farnborough issuing their report A192 on 15th January, this dealing with production A11 T5563, whose Ford V8 engine had been fitted with cast iron cylinder heads instead of the standard aluminium parts. A set of comparative hill climbing trials had been undertaken between the 22nd and 27th December, the tank being weighted to 11 tons and successfully achieving three climbs both with the aluminium heads and then with the cast iron heads fitted. These were a stop and restart in 1st gear on Miles Hill No. 4 slope (1 in 2.46), a climb in 2nd gear to within eight or nine yards (7 – 8 m) of the summit of No. 7 slope (1 in 3.12), and finally a climb in 2nd gear of No. 8 slope (1 in 3.18). A climb of the shallow Beacon Hill (1 in 10.45) was undertaken with both engine

Infantry Tank Mk. I T5556 of 'B' Company on exercise with the North Staffordshires on 11th January 1940, accompanied by a Light Tank Mk. VI B. This is one of the early machines from the second production batch and retains the original design of driver's visor, the new design of stowage boxes also being absent. This picture gives a good view of the cable to the aerial base. (IWM F2104)

configurations, the tank being slightly faster with the aluminium heads, averaging 4.91 mph (7.90 km/h) as against the 4.43 mph (7.13 km/h) achieved with the cast iron heads. Overall the MEE surmised that "The hill climbing performance of this vehicle is almost identical when fitted with either aluminium or cast iron cylinder heads." R.G. Shaw, the chairman of the Mechanization Board's 'A' Committee would further submit that:

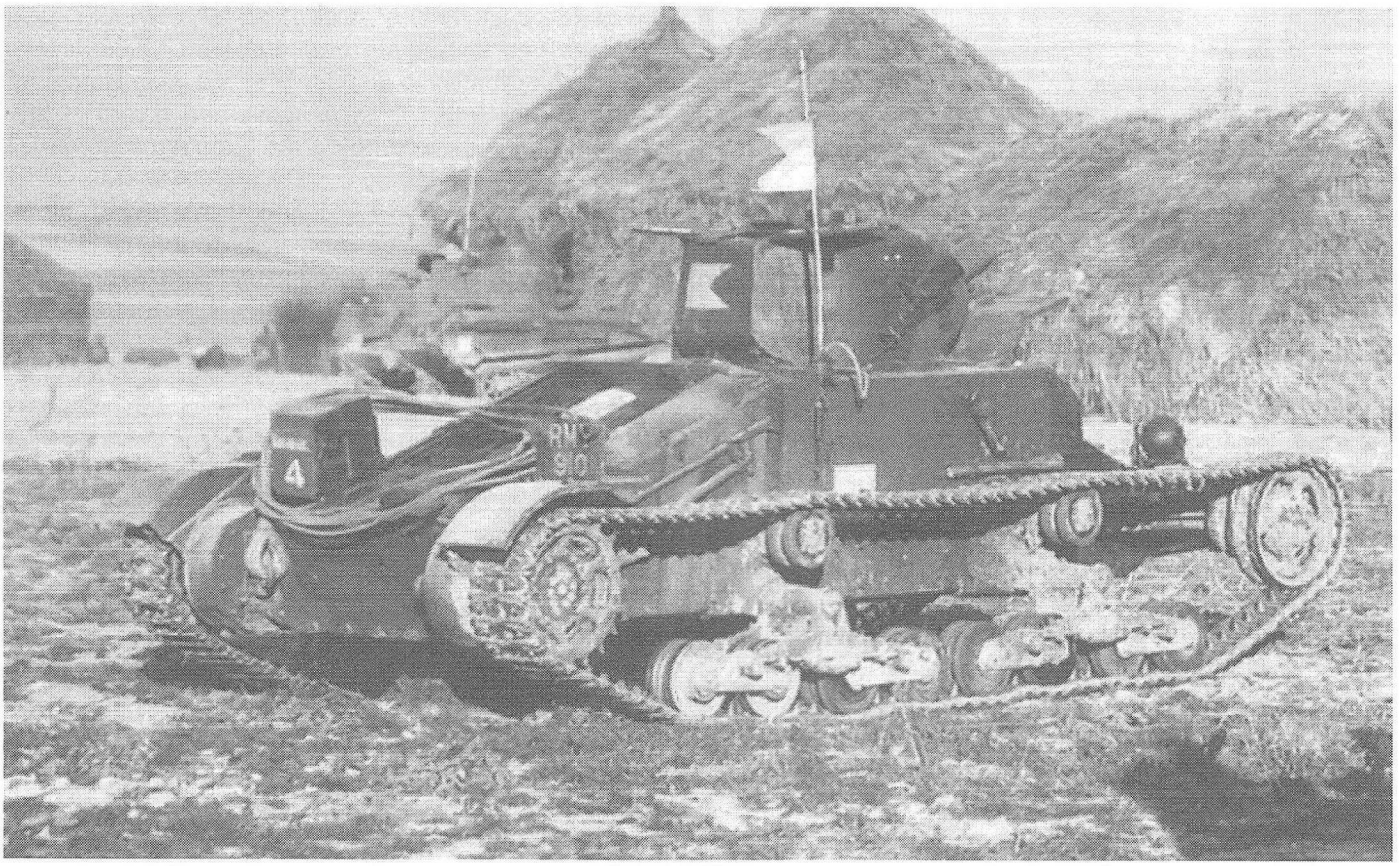
> This trial was undertaken as a result of the numerous failures which were experienced with the aluminium heads on Tanks, Infantry, Mk. I. Substitution of cast iron for aluminium heads has already been recommended and approved.

Over in France, Justice Tilly journeyed to Amiens on 15th January to meet Michael Dewar, another Englishman at Hotchkiss who was the director of their works in Paris. While he was there the BAFV would also meet up with Captain Henry Foote of SD7, with Foote accompanying Tilly back to Arras. The pair of them agreed that the current two-man version of the Hotchkiss was only acceptable if it was immediately available as a stop-gap, while for the purported three-man variant, "This should not be considered until trials had taken place in France on similar ground, to which it might be expected to have to fight over." Foote set down for Tilly the expected organisation of the 1st Army Tank Brigade, with 23 of the Infantry Mk. I tanks with 4 RTR to be substituted by Infantry Mk. II's by 1st June. The Brigade headquarters and 7 RTR were to be complete by 1st April, the latter being equipped with 27 Mk. I and 23 Mk. II infantry tanks. 8 RTR were to be fully equipped by 1st May, again with 27 Mk. I and 23 Mk. II tanks, although the Infantry Tank Mk. II's in this regiment were expected to have co-axial Besa machine guns instead of Vickers. In contrast to these expections, 7 RTR had by this time received only ten Infantry Tank Mk. II's, while 8 RTR had not received any. The following morning, 16th January, Tilly visited the BEF's Chief of Staff (CGS), Lieutenant-General Henry Pownall, along with his deputy, Philip Neame, and the commander of the 1st Armoured Division, Major-General Roger Evans. The ostensible purpose of the meeting was to discuss the RAC higher organisation that had originally been drafted by Frederick Hotblack, although a number of other subjects were aired, including the unsatisfactorily supply of tracks and spares, this pertaining particularly to the Infantry Tank Mk. I. Tilly's GSO I, Richard Lewis, had been tasked with leading a commission to investigate the BEF's repair organisation in the field, including that for AFV's. In reference to this initiative, Tilly warned Pownall and Neame of the drawbacks of returning AFV's to the United Kingdom for repair, as this would entail delays and the unnecessary use of shipping. He also pointed out that only a small percentage of skilled labour was needed for this work, and this would be better off being employed within the BEF. While Lewis was occupied with his commission, Raymond Briggs would take his place as the GSO I within the AFV Branch.

Henry Foote would accompany William Blagden on a visit to the Hotchkiss factory in Paris on 17th January, where they discussed (presumably with Michael Dewar) the possibility of mass producing the three-man version of the Hotchkiss as a stop-gap until production of the Infantry Tank Mk. II reached an adequate volume. Two days later, on the evening of 19th January the CGS, Henry Pownall, summoned Justice Tilly on the subject of his proposed supplement to MTP No. 22 Part III. This emphasized two factors that needed to be taken into consideration when mounting tank-infantry cooperation exercises, which were:

> (a) That attacks must be made with a mass of tanks and that the schemes should never be set taking into account anything less than a tank bde co-operating with an infantry bde.
>
> (b) That, as the Mark 1 Inf Tank was only a drill purpose machine, it should be assumed in schemes that Army Tank Bdes were equipped throughout with Inf Tank Mark 11.

The Staff Directorate at GHQ had issued Tilly's paper to both the 1st and 2nd corps on 18th January, without Pownall having been consulted. However, on eventually seeing the paper the CGS had felt compelled to withdraw it, and destroy every copy of it, as "It would obviously tend to destroy the confidence of the Infantry in tanks if the fact was broadcast that the one tank bn in the B.E.F. was equipped with what the experts considered to be only a drill purpose machine." This statement did nevertheless confirm that the A11 was widely regarded as a placeholder within the BEF until the arrival of the A12. Pownall had also taken exception to Tilly's first statement, as he underlined that "Infantry can never expect always to have tanks in the attack on the scale of one Army Tank Bde to one Infantry Bde." Richard Lewis's "Committee to Investigate the Repair Organisation in the Field" would arrive at GHQ at Arras on 20th January, with Justice Tilly and William Blagden being called to give evidence to it that evening. This had been assembled in London five days earlier, its members being Lewis himself and two civilians, J.H. Bruce of the London Passenger Transport Board and R.G.B. Helbing of Standard Telephone & Cable Co. Ltd. Their visit to France, which had commenced that day, was to last until the end of the month and include visits to light aid detachments in the forward areas, ordnance field parks, advanced and base workshops, and the technical branches of GHQ. The AFV Branch's diary documented that:



Rear three-quarter view of T5556 showing the relocated stowage bin for the jacking blocks on tanks from the second production batch. The double pointed yellow pennant, which is also painted on the rear of the turret, indicates that this is a company command tank. Also visible is the new stowage position for the jacking blocks, around which is the towing cable, which is in a non-standard location, this indicating that its anchors at the nose of the vehicle have not been fitted. (IWM F2108)

> The chief points discussed covered repair and supply organisations for all types of vehicles and the distribution of labour both skilled and semi-skilled between forward units, the various repair organisations and U.K., also the various civilian sources of supply of such labour.

This conformed with the committee's brief, although the unstated significance of its necessity was that it revealed the lack of attention that had been paid to these subjects prior to the commencement of war. This in turn had principally manifested in a shortage of breakdown lorries and of skilled personnel within the BEF. On 23rd January Tilly and Blagden visited the Advanced Ordnance Depot at Arras, along with Brigadier Leslie Williams of the Central Ordnance Depot at Chilwell in Nottinghamshire, and William Rootes, the chairman of automobile manufacturers Rootes Ltd. It was thought that the depot would have "considerable difficulty" in transporting sufficient spares should a move forward be ordered, this being pertinent as the French defence plan involved advancing the forces on the frontier to the River Dyle in Belgium in the event of a German incursion into that country. It was also noted that although spares for 'B' vehicles were up to schedule, there were apparently no spares available for 'A' vehicles.

Back in England, on 25th January Mechanization Board minute A3189 would recommend a number of spark plugs with ceramic insulation for the Ford V8 engine, these having an advantage over the previously installed mica insulated plugs due to their comparative ease of manufacture, mechanical strength and absence of porosity. This would be approved by minute A3236 three months later. The next day, 26th January, Alexander Davidson, in his new role as Controller of Mechanization Development (C of MD) within the Mechanization Board, held his weekly meeting, the minutes suggesting that it was planned to bore out the 37 mm gun of the Hotchkiss tank to 39 mm to suit British 2 pounder ammunition. It also appears that two tank designs were planned to receive a common turret mounting the bored-out 37 mm and a co-axial Besa. The brief minute did not allude to what these "small infantry tanks" might be, although one of them would almost certainly have been the three man Hotchkiss tank, with the other likely being a three man version of the A11. The Mechanization Board were also seeking details of

the mounting for the Hotchkiss gun from A.V. Golding, who had taken up his appointment as liaison officer to the French *Ministère de l'Armement* (Ministry of Armaments) three days earlier. The design for the mounting of the bored-out 37 mm gun was to be undertaken by Vickers-Armstrongs at Chertsey, this no doubt being the responsibility of their mountings designer, William Kilbourn. In France, Justice Tilly and William Blagden set off to Paris on the morning of 29th January, along with Alec Gatehouse of 4 RTR, with A.V. Golding and a French liaison officer, *capitaine* Vivier, joining them on arrival. They then proceeded to the Hotchkiss factory where the production of the three man tank was discussed with Henry Ainsworth. Tilly told Ainsworth that Michael Dewar had undertaken to produce a prototype of this model at the firm's expense, with delivery expected in eight or nine weeks. However Ainsworth refuted this, stating that Hotchkiss could not even produce additional tanks of the current two man design without armour castings supplied from England. Blagden did however provide Ainsworth with a drawing of the three man tank, this likely having been produced by the Mechanization Board.

During the afternoon Tilly, Blagden and Vivier met *l'inspecteur général de chars*, *général* Keller, at the *Cercle Militaire*, the main officers' club in central Paris. Keller forecast that by April the French would have achieved their immediate requirements for tanks, and so would be prepared to dispose fifty two-man Hotchkiss tanks to the British in early April, and a further fifty shortly after that. Regarding the requested provision of Hotchkiss castings by the British, Keller stated that if the French Ministry of Armaments insisted on these, they would need to be delivered in July or August, although he opined that the Ministry might be prepared to take raw steel in lieu of castings. Tilly, Blagden and Vivier accordingly called in at the Ministry of Armaments to confirm whether they would indeed accept raw steel instead of castings, although no answer was obtained. Concerning the shortage of spare parts, this was now deemed to be sufficiently serious for the Commander-in-Chief, Lord Gort, to write to the War Office in order to warn them of the gravity of the situation. In the case of the Infantry Tank Mk. I, of which there were fifty in the theatre, the available spares amounted to sixteen pairs of tracks and not a single pair of sprockets,

*Another tank of 'B' Company (*Demon*) during the exercise on 11th January. The AoS plate with the number 4 on a red background and white upper bar indicates that 4 RTR were at this time temporarily attached at corps level (in this instance 1st Corps) instead of to GHQ. Note also the white BEF identification square painted on the small raised cover plate over the engine air induction pipe to the carburettor.* (IWM F2107)

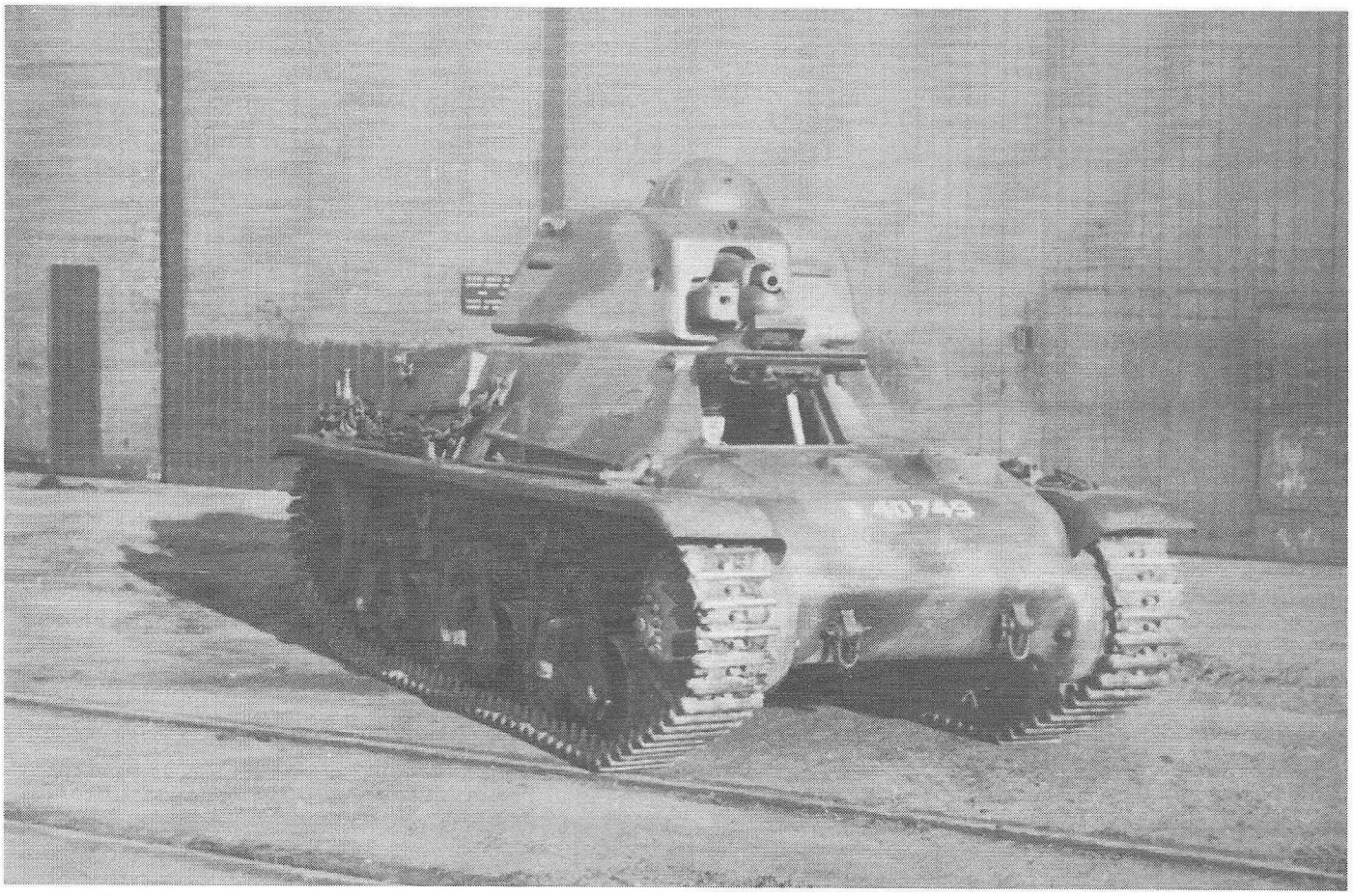
with 32 track pairs and 25 sprocket pairs being "due in" but not having arrived. Gort highlighted that:

> It will be seen that the deficiency in the matter of tracks and sprockets is particularly serious. So grave is the position, that, in order to keep in hand the bare minimum mileage essential for operations, I have been compelled to cancel all field training of R.A.C. units. I have, furthermore, been compelled to curtail the training of those R.A. Regiments which are equipped with light dragons, and of the carrier platoons of infantry battalions.

He further ventured that the tracks and sprockets due in might take a long time to arrive in France, as they may have included parts that had been ordered and not yet completed by the manufacturers, adding that "If this is so, it reveals an unsatisfactory state of affairs and I would request that full and timely information regarding the situation in the United Kingdom may be made available." Gort considered that the stocks of tracks and sprockets ought to be on a scale sufficient to re-track 100% of the vehicles in force, although in the case of the Infantry Tank Mk. I he stated that the scale of spare sprockets could be half that of the tracks. This implied that for the fifty tanks of 4 RTR, 50 pairs of tracks and 25 pairs of sprockets would be adequate, these figures being maintained on a rolling basis. Other spare parts and assemblies were also deficient, and for the Infantry Tank Mk. I these included engine and gearbox components, starter motors, gear selector shafts and oil gauges. It was proffered that:

> The main cause of this situation appears to lie in the fact that whenever orders are placed for new vehicles, orders are not given concurrently for a sufficient number of spare parts. It is estimated that the equivalent of 1½ A.F.V's worth of spares should be held for

Infantry tank Mk. I in the RAOC workshop at Farnborough during 1940. Note how the jacking blocks have been arranged to support the jack itself, which is supporting the tank under the idler adjuster assembly while the front offside suspension unit has been removed. This was an approved jacking position according to the vehicle instruction book, the detached suspension unit being visible on the far left of the picture. (IWM H1138)



Hotchkiss H35 Serial No. 40749, which was tested at the MEE during February 1940. This gave a favourable impression according to report A237, covering 252 miles (405 km) with no mechanical defects, and displaying a better bog crossing performance than the Infantry Tank Mk. I. Any possibility of sourcing this type from the French was however foreclosed by the French surrender in June that year. (National Archives)

every A.F.V. held on charge. This does not necessarily mean component for component, the exact detail of necessary spares can only be estimated by technical experts with access to statistical returns.

The shortage of spares was ultimately due to the emphasis on the production of whole vehicles, which the provision of spares would necessarily interfere with. The proportion of spares would be weighted to those items most prone to wear, which in addition to tracks and sprockets would be the main automotive components, especially engines, clutches and final drives. Gort furthermore ventured that:

> A subsidiary cause appears to be delay in the forwarding of spares from the Base Depot through the normal channels to units. The classification, storing and forwarding of spares and items of equipment not common to the whole Army calls for a high form of specialisation on the part of personnel handling them, and the need for this specialisation will become more and more marked as further different types of A.F.V. continue to arrive.

It should be noted in this regard that in addition to the spares held in depots, 4 RTR held ten track pairs and five sprocket pairs as immediate replacements. The C-in-C acknowledged that the auditing of the BEF's spares was made difficult by the dispersion of the various ordnance depots, the absence of parts lists for the various vehicles in service, and the difficulty that non-technical storesmen experienced in identifying specialised AFV components, although he nonetheless asserted that "I cannot stress too strongly the fact that the operational value of A.F.V's is seriously curtailed by the non-availability of an adequate supply of spare parts." On 7th February, Brigadier Arthur Kenchington of SD7 informed Justice Tilly by telephone that a new system for the supply of spares and the repair of vehicles had been approved by the Principal Ordnance Mechanical Engineer (POME) at the War Office, Major-General Albert Valon. This new system had been devised by Tilly himself, in his *Paper on the Organization of the Maintenance and*

Repair of A.F.V.s in the Field, Kenchington stating that a committee was being formed within the War Office to consider the establishments that would be necessary to put the scheme into effect. Kenchington also informed him that the Ministry of Supply had curtailed their orders for the new Infantry Tank Mk. IV, which was a "shelled area" tank that had been developed by shipbuilders Harland & Wolff in Belfast as the A20. This was a smaller tank than that being developed by Albert Stern's Special Vehicle Development Committee, it being somewhat analogous to the Char B series. The General Staff had not been convinced by the reasons given for reducing its production, which were a lack of factory floor space and the anticipated complexity of the manufacturing process. They had therefore asked the ministry to quantify the floor space required and offer suggestions as to how the production process could be simplified.

William Blagden would return to England for a liaison visit on 14th February, calling in first on SD7 in the War Office, where he met Henry Foote, who informed him that the purchase of one or two hundred two man Hotchkiss tanks might be possible. These would be used in place of Infantry Tank Mk. I's in the new 21st Army Tank Brigade, being distributed at 27 tanks per battalion, these presumably complimenting 23 Infantry Tank Mk. II's. Blagden then met Colonel Charles Radclyffe of the OS5 branch of Ordnance Services, where he enquired as to the status of a new design of cast steel tracks for the A11. Radclyffe informed him that these tracks had a longer pitch than the current cast iron tracks, this being 4 in. (10.4 cm) against the present 3½ in. (8.9 cm), and so new sprockets would also be needed to accompany them. He also advanced that no changeover to the steel tracks could be effected until enough had been produced to equip a complete battalion plus 125% spares, although in the meantime 200 pairs had been ordered by the Ministry of Supply. The driver's change speed lever on the Ford V8 engine for both the Infantry Tank Mk. I and the various carriers appears to have been prone to breakage, as this issue was also discussed between Blagden and Radclyffe. The Ministry of Supply was then visited, with Blagden meeting with the Director-General of Tanks and Transport (DGTT), Peter Bennett, the Director of Mechanization, Brigadier John Crawford, and his assistant (the ADM) Colonel Leonard Hailey-Gardiner. Blagden informed them of Henry Ainsworth's refusal to build a three man variant of the Hotchkiss, although Blagden alleged that he had previously been open to the idea, under the encouragement of Michael Dewar. He then recorded that:

> Brigadier Crawford then explained that the General Staff had definitely ruled out the 2-man and 3-man Infantry tanks, and that plans to mass-produce a three man Hotchkiss and a three man Vickers tank had therefore been abandoned; all available capacity was now being devoted to the production of Valentines and Infantry Tanks Mk. IV. These tanks, however, could only be produced in comparatively small numbers.

The "three man Vickers tank" mentioned here would have been an A11 with a two man turret, although it should be recalled that the Valentine was a three man tank, and one that was being produced by Vickers. The responsibility for the design of the Infantry Tank Mk. IV had by this time been transferred from Harland & Wolff to Vauxhall Motors Ltd. in Luton, Crawford imparting that "The Vauxhall Company which was prepared to turn out 10 Hotchkiss 3-man tanks per week could not possibly produce more than two Mark IV. tanks." The following day, 16th February, Blagden once again went to the Ministry of Supply, where he met Leonard Hailey-Gardiner, who stated that there was still a possibility of buying one hundred two man Hotchkiss tanks from the French, although "this was becoming more remote now that the French are contemplating equipping their cavalry with them." The cavalry formations referred to here were the *divisions légères de cavalerie*, who would receive a small allotment of twelve H35's for their armoured car regiments. Blagden visited the Central Ordnance Depot at Chilwell in Nottinghamshire the following week, and on 20th February met their officer in charge of spare scales, Major Frederick Johnstone-Hall. Regarding the Infantry Tank Mk. I, Blagden discovered that "The spares situation of this vehicle is particularly unfavourable and Major Johnstone Hall explained that at the time when he had put in his demands, the vehicle was believed to be obsolescent and the quantities he had asked for were very much cut down." Unfortunately for the War Office, their eagerness to condemn the A11 to obsolescence was being undermined by the complexities hindering suitable replacements.

In the meantime in France, the proposed trials of Dannert wire to be conducted by 4 RTR had been scheduled for 19th February, although these were frustrated by the thaw precautions that stipulated that no vehicle over three tons could use the public roads. On 28th February Justice Tilly called in on the battalion prior to their short move southwest to Domart-en-Ponthieu, which was itself seventeen miles (27 km) northwest of Amiens. He informed them that when their parent 1st Army Tank Brigade arrived in France it would be located at the RAC training area at Pacy-sur-Eure, where the battalion would join them. This arrival was thought to be imminent, as 4 RTR were instructed to send an advance billeting party to Pacy. The Dannert wire trials eventually went ahead on 4th March, these being witnessed by William Blagden and Francis Arkwright,

the latter of whom compiled a report on the events. The trials encompassed seven tests, the first six of which utilised wire from two different manufacturers, each one being driven over by three vehicles, the first being an Infantry Tank Mk. I, the second being a Light Tank Mk. VI B, and the third being a scout carrier. For each of these tests, three Dannert coils were used, these being arranged one behind the other at a distance of ten yards (9 m), all the coils being bent into a 'U' shape and pegged to the ground, with the points facing the approaching vehicle. For the first three tests, coils made by Georges Renier SA were employed, with the Infantry Tank Mk. I passing this obstacle at 5 mph (8 km/h) with comparative ease, its speed not being affected. Some of the wire was picked up and thrown clear after forty yards (~40 m), although it was observed that "The tank appeared to knock the wire flat and trample over it, which implied that the wire laid on the ground is not high enough." For the second trial, with a Light Tank Mk. VI B, the ends of the coils were placed more closely together so that they engaged the "horns" of the vehicle, these being the front projections of the idler wheels and the tracks ahead of the hull. The tank approached the obstacle at 20 mph (30 km/h) and was stopped with a jerk as the wire was picked up and jammed in the trackguard, with Arkwright positing that a slower approach speed may have allowed the tank to pull through. For the third and final run of this series, the scout carrier moving at 6 to 8 mph (10–13 km/h) was also caught up in the wire of the second coil and turned sideways, although it was able to back up and cross the final coil. The second trio of trials utilised wire made by Richard Johnson and Nephew Ltd. of Manchester, and in the case of the Infantry Tank Mk. I Arkwright reported that "The tank rode over the top of the obstacle which made no impression on it whatever", as "The horns are high enough to meet the top of the coil, knock it flat and ride over it." Unlike the first test with the Infantry Tank Mk. I, the ends of the coils were placed so that they met the horns of the vehicle, although the A11 had an advantage in that it wasn't fitted with trackguards that could help trap the wire. For the fifth test, the Light Tank Mk. VI was driven towards the obstacle at the reduced speed of 10 mph (16 km/h), this proving a successful gambit, as "The tank was slightly checked at the third coil, but not stopped, and the wire was all thrown away after about 30 yards [~30 m]." The drive sprockets on the Light tank were at the front of the vehicle, it being noted that:

> The offside sprocket entered the end of the coil, but apparently insufficient number of strands were picked up to stop it. It should be noted that the slower speed prevented any 'bucking', and the tank never dipped its horns into the coils.

For the sixth and final test of this series, the scout carrier travelling at 6 mph (10 km/h) was quickly stopped at the first coil, the track jamming and turning the vehicle sideways, with any further attempt at crossing being abandoned. An additional seventh test was then performed, with the three coils being brought together to form a stack, with two coils on the bottom and one on the top, a 'U' shape once more being arranged so that the points met the vehicle horns. Only the Infantry Tank Mk. I was employed in this instance, it being initially stopped by the obstacle when in 3rd gear, but managing to get through after changing down to 2nd. It was nonetheless considered that a second such obstacle would have stopped the vehicle, as this arrangement of coils prevented the A11 from crushing the wire, and so ensured that the horns entered the coils. Arkwright drew a number of conclusions from the overall trial, such as that "The obstacle appeared to be effective only when the horns entered the end of the coils", because "Once the ends were knocked flat the whole coil appeared to go flat like a row of ninepins." It was also the case that "The mudguards of the tanks appeared to make it much more difficult for the tank to throw the wire clear", while "Slow speed appears to be the most effective way of attacking the obstacle." He felt that one simple alteration would have rendered the crossings more difficult, as "The wire should be loose and not pegged, to allow it follow and cling to the tracks as long as possible." Finally, he noted that the wire employed was indeed substandard, as "The wire was easily cut by 12" [30 cm] cutters. It was easily bent by hand, and had no spring in it." On 7th March the Military Co-ordination Committee issued a memorandum on tank production written by the Minister of Supply, Leslie Burgin, as paper MC(40)59. Burgin identified three major reasons for the current unsatisfactory situation, the first being that limited liability had led to a focus on smaller scale mobile warfare, such that:

> The plans were laid for a possible war in the Middle East and as it was not then anticipated that we should ever have another large force in France, preparations were made for a war of movement, and little was done to actually provide for the large scale warfare on the Western front with which we are now faced.

The second reason proffered was that "The modern tank with its heavier armour is a very different production problem from the tank of the last war." This was particularly the case with the Infantry Tank Mk. II, while the proposed Infantry Tank Mk. IV presented a similar challenge. The last reason tendered was that it was now considered that eighteen months was the optimum period for getting a new model into production, and "The work is much heavier than

Production Infantry Tank Mk. II T6729 on test at the MEE. Small numbers of these formidable tanks started to become available during late 1939, these being concentrated with 7 RTR in England. (National Archives)

that to which the production industries such as the Motor Lorry Trade have been accustomed ... it means waiting for large numbers of additional machine tools". In fact, subsequent experience would indicate that two years was the minimum time required to put a tank into production and expect reasonable reliability, with another year being required to iron out any major issues uncovered during service use. Of the models currently in production, Burgin noted that "The Infantry Mk. I is well armoured but is armed only with a machine gun which is slow." He also recognised that "It is the shortage of Infantry tanks which is giving the greatest concern and where the greatest effort is being made to increase and accelerate production, but it is a slow business". For the three newer models of Infantry Tank, he mentioned that the group of companies building the Mk. II mainly consisted of locomotive works and heavy engineering firms, with output expected to rise to 20 per month by May, and later to 40 per month. Burgin conceded that this tank was "a difficult job to produce", this being because the heavy armour castings that constituted the hull and turret required an excessive amount of fettling and dressing. It was also the case that the complex Wilson epicyclic gearbox and Rackham clutch steering that were unique to this model were meeting numerous development and production issues. The Infantry Tank Mk. III (Valentine) was a much simpler design, based as it was on the A10 Cruiser tank, although output of this model was being impeded by the need to build up sufficient industrial capacity, as:

> The problem, apart from the labour difficulty, is not the erection of the tanks. It is firstly to expand the production of armour plate and to arrange for its machining, and secondly, to provide suspensions, transmissions and gun mountings. These all require heavy machine tools, of which there is such a shortage.

Production of the Infantry Tank Mk. III had originally been estimated to reach 40 per month by November, although this had been revised to 68 per month by February 1941. Burgin was not satisfied with this however, and the Ministry of Supply were now planning to produce 100 per month by the latter date, with an ultimate monthly output target of 120. It should be recognised, however, that if the Valentine design had been taken up when it was first offered, the build up in production could have been started a year earlier, with tanks already coming off the line.

For the Infantry Tank Mk. IV (A20), this was described as "the heavy tank specially designed to meet the conditions expected as the present war develops on the Western Front." As such, it was considered to be the main tank for offensive operations, being capable of crossing shelled areas. Burgin stated that "The pilot is due in June and although we cannot hope for any appreciable number for 1941 every effort will be made to have substantial deliveries coming through by the beginning of 1942". This gave an insight into how British planners were expecting the war to progress, with any German advance being initially held by the French, albeit with British assistance, using the tanks that were currently available. The British would then build up their forces and lines of communication within France, with the Allies expecting to go on the offensive in 1942 with tanks that were specially developed for the siege warfare conditions expected on the Siegfried Line. This would be undertaken by shelled area tanks such as the A20 and Char B with their long track bases, and giant Char de Forteresse tanks, such as those being developed by Albert Stern's SVDC and the French ARL and FCM combines. Indeed the British were developing an even more extraordinary machine for this purpose in the Cultivator No. 6 that was being developed by the Ministry of Supply's Naval Land Equipment branch. This was a giant trench cutter that was intended to dig a submerged trench through the Westwall defences, thereby facilitating a concentrated attack by following tanks and infantry. The prospect of obtaining Hotchkiss tanks to supplement British production was now fading, as:

> To supplement the numbers of infantry tanks, discussions have taken place with the War Office on the possibility of a smaller type. The Hotchkiss 2-man tank (French) has been investigated. The G.S. would accept some if they could be got at once. A scheme was discussed with M.Dautry when he was here. They will provide one tank for every two sets of castings we deliver to them. While we might go into production with it in England we have no gun that would fit into it. The French can provide none and it would take us 18 months to produce their gun.

The proposed three man variant of the Hotchkiss was also now a faint hope, as "It is not a practicable proposition to adapt the Hotchkiss construction to take a 2-pdr. with three men as crew." Regarding the British models, the Minister of Supply identified three "bottlenecks" impeding production, the first of these being "machine tools, where the special difficulty is the late development of the infantry tank." The second impediment was the provision of sufficient labour, as:

> We are asking for the retention of all men engaged on tank production whatever their age and the return of a number of men already mobilised. New labour can only be produced slowly particularly for some special processes and much of the work is too heavy for women.

Finally he reckoned that "Quantities of raw materials reach such dimensions in the latter stages of the programme that we are having to create additional capacity for Armour Plate and Castings, Malleable Stampings etc., and we rely on our supplies not being taken for any other project." Raymond Briggs, who was now the AFV Branch's GSO I, would follow the example of William Blagden and pay a visit to England during the second week of March, his first port of call being the MEE at Farnborough on 7th March, where he witnessed a parallel trial of Dannert Wire. He related of his observations that:

> Briefly, the impression gained was that the German imported wire was slightly more efficacious than the British made wire, but that neither type of wire was as satisfactory as the original coils brought over to the United Kingdom by Herr Dannert two or three years ago.

The next day, 8th March, Briggs went to the SD7 branch at the War Office, where he learnt of the latest forecast for the dispatch of the remainder of the 1st Army Tank Brigade to France, such that:

> Tank Brigade Headquarters and 7.R.Tanks will arrive about 15th April, 1940. 7. R.Tanks will organise on basis of each Company consisting of two sections of Mk. II Infantry Tanks and three sections of Mk. I Infantry Tanks. Number of Infantry Tanks in each battalion — 27 Mk. I, 23 Mk. II.

This was of course in line with the instructions issued by Arthur Kenchington on 18th November the previous year. The arrival of these units on the Continent had of course been expected during March, with Briggs explaining that:

> The delay in probable arrival has been caused owing to the necessity for increasing the performance in mud. The Mk. II Infantry Tank[s] which will arrive have the belly raised about 6" [15 cm]. Each tank will also bring with it spuds for fitting to each track. These spuds are easily detachable, and can be fitted to a tank by two men in an hour.

8 RTR were scheduled to arrive about 1st June, while in the case of 4 RTR Briggs relayed that "It is hoped to ship Mk. II Infantry Tanks, for 4 R. Tanks, at the rate of about three or four per week commencing about the 15th April." He then forecast that "It is anticipated that 4.R.Tanks will be completed to their establishment of 23 Mk. II Infantry Tanks by 1st June." This would mean that the whole of the 1st Army Tank Brigade would be fully equipped and in France by that date, and "As 4.R.Tanks is equipped with Mk. II Infantry Tanks, it is suggested that the 23 Mk. I Infantry Tanks rendered surplus shall be put into reserve." Briggs revealed that the Army Council had yet to accept Frederick Hotblack's proposal for an RAC higher organisation, built around the AFV Branch, to control the armoured formations within the BEF. Nonetheless, the RAC training area was being established at Pacy-sur-Eure, with a gunnery range having been obtained at Meuvaines on the Normandy coast. The AFV Branch had also been keeping up with the training of 4 RTR in France, with Justice Tilly and Francis Arkwright having attended an exercise with the 3rd Division on 8th March, while on his return Briggs observed a trial of the battalion's tanks attacking through smoke on 18th March. 4 RTR also took part in an exercise that was conducted by the 17th Infantry Brigade Group of 5th Division on 27th March, in the area of Auxi-le-Château on the River Authie. This was a simulated combined infantry and tank counter-attack, the experience gained being the subject of a talk and subsequent report by the divisional commander, Major-General Harold Franklyn, whose general impression was that "The machinery for issuing orders was obviously rusty" and so the "Battle machinery requires oiling". Problems had manifested at the preparation stage, as the "Umpires in the enemy position saw nothing until the attack started, but there was too much crowding in the villages near the start line and casualties from enemy O.P." The "OP" in this instance referred to an artillery observation post, it being additionally noticed that "The First wave of Tanks were not given sufficient start and as a result the second wave and the infantry with them had to mark time." The infantry's own tracked vehicles had made something of a nuisance of themselves, as:

> The carriers tried to become tanks, moving about largely amongst the first wave. They should move by rushes from one fire position to another, covering the advance of the leading wave, and covering the flanks of the attack.

There was a change in command for 4 RTR on 29th March, when Alec Gatehouse returned to England on leave, prior to his reallocation to the Middle East. He was succeeded by his second-in-command, Major James Fitzmaurice, who would be promoted to Lieutenant-Colonel the following month. The matter of accepting Hotchkiss tanks arose once more at a meeting at GHQ on 30th March, this being attended by Lord Gort, Henry Pownall, Justice Tilly, and the Assistant Chief of the General Staff, Laurence Carr. On this occasion Gort turned down the possibility of adopting them due to the latest estimated delivery date (spring 1941) and so Carr was given the thankless task of soliciting the French for Char B's instead. This was to be on the same offer basis that the French had put forward for the Hotchkiss, which was for the British to supply two sets of castings for every one tank received. Regardless of Gort's preferences, the desperation of the British to acquire any modern tanks would mean that the Ministry of Supply's tortuous negotiations for the Hotchkiss model would continue. On 31st March Brigadier Tilly wrote to the BEF's Deputy Chief of Staff (DCGS), Major-General Frederick Witts, explaining to him that he had visited the Ministry of Supply in London to discuss the ongoing issue of inadequate spares with the Director-General of Tanks and Transport, Peter Bennett, and his Director of Mechanization, John Crawford. This does not appear to have been a particular success, with Tilly recalling that "I could get no definite information re the supply of spares, but gathered that eventually fresh plant would be put down to manufacture spares without upsetting production of A.F.V's." In a subsequent conversation with Brigadier Leslie Williams of Ordnance Services and Lieutenant-General Dudley Collins, the Deputy Quartermaster General, he discovered that they were both worried about the lack of spares for the Infantry Tank Mk. II, as well as for the A13 Cruiser tanks. Tilly informed Witts that he had emphasized to both Williams and Collins:

> That considerable training would have to be undertaken by 1st Army Tank Bde and 1st Armd Div after arrival in France, and that the training of the Army Recce Bdes would have to continue, and that the nature and length of such training was largely governed by the supply of spares known to be available, as a proportion must be kept for active operations.

The armoured reconnaissance brigades were new formations that had been created by removing the light tank equipped divisional cavalry regiments from the infantry divisions, and pairing them together, to create two brigades of two regiments each. These were to be tasked with providing a close protective reconnaissance screen in front of the main forces. Tilly had moreover emphasized:

> That A.F.V's without an adequate supply of spares were not merely no asset, but a very definite liability, as, at

First production Infantry Tank Mk. III (Valentine) T15946 undergoing test at MEE during May 1940. This capable and durable machine would effectively supersede the Infantry Tank Mk. I. (National Archives)

worst, a breakdown during active operations probably meant that a machine would have to be destroyed, and, at best, that powerful fighting machines and their trained crews would be standing idle.

In response, Tilly was assured that "every effort was being made to bring the spares available up to 100%, and that, as far as possible, the exact situation would be communicated to G.H.Q., B.E.F. before the arrival of 1 Armd Div and 1 Army Tank Bde." While he had been in London, Tilly had also visited the War Office, having spoken to the Director of Staff Duties (DSD), Major-General Edwin Morris, about the RAC training area at Pacy-sur-Eure. The BAFV urged on Morris that the War Establishment for the training area be approved as quickly as possible, as "at the moment there was no authority for the Colonel and Staff Captain employed there, also that the establishment asked for was urgently required before the arrival of 1 Army Tank Bde and Army Recce Bdes, and the move of the R.A.C. base depot to this area." The RAC Base Depot was to contain the workshops, stores, and AFV recovery sections needed for supporting the armoured units in the forward areas, with both the 1st Army Tank Brigade and the 1st Armoured Division expecting to commence training on their arrival in France. Morris assured Tilly that the establishment for Pacy had been approved subject to scrutiny from the War Office's Finance directorate, and that he would do his best to expedite it. A few days before meeting the DSD, Tilly had called on the Assistant Director of Transportation at the War Office, Colonel Ralph Micklem, to air another issue that had been concerning him, this being the provision of railway trucks (or "flats") in France capable of carrying tanks. Although the BAFV did not provide any detail of these discussions, at a meeting with the DCGS, Frederick Witts, on 1st April he indicated that the shortage of trucks was disturbing him as much as the lack of spares.

The Military Co-ordination Committee held its sixteenth meeting on 8th April, which was now being chaired by the First Lord of the Admiralty, Winston Churchill, after the resignation of Lord Chatfield

a few days earlier. Also attending this meeting was the Secretary of State for War, Oliver Stanley, who had succeeded Leslie Hore-Belisha after the latter's dismissal in January, Hore-Belisha having become irreparably estranged from Lord Gort and the General Staff. Stanley informed the attendees that to date 121 Infantry Tank Mk. I's and 35 Infantry Tank Mk. II's had been produced, while by September he expected all 139 Mk. I's and 160 Mk. II's to have been completed, as well as 22 Mk. III's (*i.e.* Valentines). This would provide sufficient Infantry tanks to equip two army tank brigades, although "it would only leave a small reserve and no tanks at all for training." Of the Infantry Tank Mk. IV, Stanley reaffirmed Leslie Burgin's previous assertion that this "was the heavy tank specially designed to meet the conditions expected if the war developed on the Western Front", and that "The pilot model would not be ready till June this year and delivery in large numbers could not be expected before 1942." Churchill was rather sceptical about the projected figures, pointing out that the estimates for future production were being continually revised downwards, with the DGTT, Peter Bennett, attesting that this was due to the need to incorporate modifications and the need to switch priorities, for example from the A10 Cruiser Tank Mk. II to its Infantry tank derivative, the Valentine. Churchill nonetheless asserted that "it now seemed too late to take effective steps to increase production for the campaigning season of 1940", and enquired as to the situation with the Hotchkiss tank. Leslie Burgin replied by referencing his previous memorandum on tank production of 7th March, averring that an agreement on supply had been reached with the French, although "no substantial results could be expected until the end of 1940, as it would be at least three months after delivery of castings in bulk before the French would start to deliver Hotchkiss tanks to us." This was a reference to the convention that the British were to provide two sets of castings for every one Hotchkiss tank the French delivered in return. The Assistant Chief of the Imperial General Staff (ACIGS), Major-General Laurence Carr, then interjected, submitting that:

> General Gamelin was now unwilling to agree to the early supply of these Hotchkiss tanks. There was, however, a possibility that in return for the delivery of castings for the Hotchkiss tank, the French would supply "Char B" tanks. Hotchkiss tanks were only acceptable this year as a stop-gap, and the arrangement by which delivery would not begin until the end of the year was unsatisfactory. We should be very glad, however, to get 'Char B' tanks for use in 1941.

It should be recalled that Lord Gort had tasked Carr with the job of sourcing Char B tanks during the meeting at GHQ on 30th March, their apparent availability likely being the result of hope rather than expectation. *Général* Maurice Gamelin was the Chief of Staff of the French Army, and the commander of the Allied forces in France, including the BEF, his restrictions dismaying Churchill further, who commented that "in view of the gloomy prospects for 1940, which it would appear we should have to accept, every effort must be made to get into the best possible position for the campaigning season of 1941." In response, Oliver Stanley estimated that 874 Infantry tanks would be available by February 1941, these including the full 139 Mk. I's, as well as 382 Mk. II's and 353 Mk. III's, the meeting minutes anticipating that:

> Production by February 1941 should be reached at 110 – 120 tanks per month, but as the Valentine tank had been ordered 'straight off the drawing board', too much reliance should not be placed on these figures. It was hoped that deliveries of the Mark IV tank would begin in August 1941, and then there was the Stern super-heavy tank to be considered.

Regarding the latter tank, Oliver Stanley had already agreed to the construction of three prototypes. However, the Military Co-ordination Committee now decided to postpone the building of these prototypes pending an investigation by the Ministry of Supply into whether this model would interfere with the production of the more mainstream types. The reason for this decision was to provide a clear path to produce of the maximum number of Mk. II, Mk. III and Mk. IV Infantry tanks, and the new Mk. V and Mk. VI Cruiser tanks. It was also anticipated that the Infantry Tank Mk. IV would directly replace the Mk. II on the production lines, and thereafter in service units. Meanwhile at Aldershot, the 1st Army Tank Brigade had been issued with orders to mobilise, this being completed on 15th April. An advance party from the brigade left for Southampton on 20th April, departing for Le Havre two days later, while the main body of the brigade headquarters was divided into a road party of wheeled vehicles and a rail party of tracked ones. The road party duly departed for the docks at Southampton on 23rd April, while on the following day the advance party in France arrived at their billets in Saint-Aubin-de-Crétot, thirty miles (50 km) east of Le Havre. The road party embarked at Southampton for Le Havre on 25th April, joining the advance party at Saint-Aubin-de-Crétot two days later, while the rail party departed England for Le Havre on 29th April, and meeting up at Saint-Aubin-de-Crétot on 30th April. On this date the advance party reported to the BEF's Area Control at Pacy-sur-Eure, and arranged billets for the headquarters personnel at

Neuilly, six miles (10 km) south of Pacy, while back in England the advance party of 7 RTR set off for France. 4 RTR had been located at Domart-en-Ponthieu since the beginning of March, where they had been engaged in company and section training. However this battalion were now to rejoin the 1st Army Tank Brigade headquarters, their advance party setting off on the 100 mile (150 km) journey south to Bueil, next to Neuilly, on 29th April, their road party following the ensuing day. 4 RTR's rail party departed Domart on 1st May, arriving at Bueil in good order the next day, the unit's war diary remarking on 3rd May that "1st A. Tank Bde H.Q arrived at NEUILLY and this Bn came under that formation for all purposes."

William Blagden had paid an extended visit to England from 12th April to 1st May, the main purpose of which was to gain an appreciation of the plethora of development issues that had emerged on the Infantry Tank Mk. IV, the first prototype of which was in construction by Harland & Wolff. During his trip he had witnessed yet another Dannert wire trial, this having been undertaken at the MEE at Farnborough using wire made by the Rendan Manufacturing Co. (Great Britain) Ltd. The Dannert wire coils had been arranged in various configurations, the first consisting of parallel rows positioned ten yards apart, the number of rows employed ranging from seven to twenty. The next configuration was a road block consisting of three coils in a 'U' configuration, as had been employed in the trials in France, these being laid out in succession at twelve yard (11 m) intervals, with up to twelve obstacles being employed. The final obstacle type had been a pyramid of three coils with one laid on top of two others, with pyramids being arranged in rows spaced thirty yards (~30 m) apart, a maximum of six rows being attempted. Four tank types had been employed in the trial, these being the Light Tank Mk. VI B, the Infantry Tank Mk. I and Mk. II, and the Cruiser Tank Mk. II (A10). They were all driven straight into the obstacles with the intention of traversing as many consecutive rows as possible. If any tank succeeded in crossing through all the obstacles in a particular run, it would continue around a short cross-country circuit before reporting for inspection. It was found that the Rendan wire failed to stop the Light Tank Mk. VI B, leading Blagden to conclude that "It must therefore be inferior to the wire brought over by Herr Dannaert [*sic*], which did." It was found that the Cruiser Mk. II was also unlikely to be stopped by the wire, although it could potentially suffer damage. Rather surprisingly, it was however revealed that:

> The two Infantry tanks are more easily stopped. The Mk. I has many projections and a rather low idler; given the 'cow-catcher' it would have done better. The Mk. II dragged all the wire into its track tunnels. This tank exhibited an undesirable characteristic in that, having been stalled in gear, it was found impossible to get it into neutral owing to loss of air pressure.

A "cow-catcher" would have been an angular projection mounted on the front of the tank that was designed to deflect any obstacles, although no such item currently existed for tank use. It was however the case that the two tanks intended for the assault role had been the least successful in overcoming the wire. Blagden remarked that once a tank had succeeded in getting through, a team of men was required to remove any wire, this being a task of varying duration, although the tank itself was likely to be undamaged. A path would also be left for succeeding tanks to follow with impunity. The most successful obstacle had been the road block, although this had the disadvantage of being extravagant in material, and ineffective on open ground. He furthermore observed that:

> There seems to be two main ways in which the tank gets entangled in the wire. The first is when a coil gets over the top of the front horn or catches on a projection on the hull, and the second is when the wire is picked up by the rear of the track when it comes off the ground, and gets carried forward.

It should be recalled that during the trial on 4th March, the Infantry Tank Mk. I had experienced no difficulty in getting on top of the wire, with Francis Arkwright's report on that event suggesting that the wire was not high enough. The Mk. I's poorer performance in this latest test suggested that the wire employed had a greater diameter to its coils, with Blagden advising that:

> The tank might be designed to avoid these forms of entanglement. The first can be dealt with by having a high front idler or fitting a cow-catcher, to push the wire down. All salient features of the tank should be faired off. For the second, the remedy would seem to be to design a track with smooth edges, and to employ a device to hold the wire on the ground up to a point past that at which the track lifts.

The 37th Meeting of the Military Co-ordination Committee was held on 6th May, the minutes of the meeting stating that "every effort" was being made to speed up the production of Infantry tanks, as supply was obviously still far short of requirements. It was acknowledged that the Air Ministry were assisting tank production by the loan of machine tools for two to three month periods, while a number of castings were being sourced from the United States of America. Progress was also being made with the Infantry Tank Mk. III, as:

Trials of the first Valentine tank were shortly to take place. It was emphasised that although the Valentine Tank was in the nature of a stop-gap and inferior to the Mark IV, it was considerably superior to the French Hotchkiss Tank. Being a lighter job than the Mark IV, it could be produced in workshops unsuitable for making the heavier models, and therefore production of the better models would not be interfered with.

Sir Albert Stern had also been pressing for a production order for 100 examples of the tank that was being evolved by his Special Vehicle Development Committee, these to be supplied during 1941. The meeting recognised that this initiative had been opposed by the Ministry of Supply, due to the effect that the assembly of these giant machines would have on attempts to meet current tank programmes, which were of course already behind schedule. The Committee nonetheless agreed to proceed with the three prototypes of Stern's tank, which they had postponed during their 16th Meeting in early April, these prototypes being expected to be ready in August. These would then be reviewed by a new forum called the Tank Board, which was to be attended by the senior personnel of the War Office and the Ministry of Supply, in an attempt to coordinate policy between the two organisations.

The prototype of the SVDC's giant "shelled area" tank. It was with tanks of this ilk that the British and French hoped to break through the Siegfried Line when it was their turn to take up offensive operations. (KCL)

4. THE ROAD TO ARRAS

On 1st May the 7th Battalion of the Royal Tank Regiment (7 RTR) were ordered to move by train to Dover over the next two days for onward shipping to France. These orders were cancelled the subsequent day, with new instructions being issued for the move to be undertaken over the 6th and 7th of May. This was to be conducted on four trains, two of which were to be allocated to the unit personnel and the other two for their vehicles, including the tanks, which now comprised the intermediate establishment of 27 A11's and 23 A12's. These trains were to be loaded onto train ferries at Dover for onward movement after arrival in France, with the tanks and vehicles remaining on their wagons during the short sea crossing. In the event three personnel trains would be employed, the first of these departing from Aldershot on 3rd May. The 1st Army Tank Brigade's RAOC Workshop were already at Dover on the SS *Shepperton Ferry*, this being a train ferry requisitioned from the Southern Railway. They had been expected to depart for France on 1st May, but were delayed due to mist and enemy mine-laying operations. They would eventually depart during the middle of the morning on 5th May, arriving at Dunkirk in the mid-afternoon. Here, they would be billeted in a transit camp near the docks, while an advance party set off for the brigade headquarters at Pacy-sur-Eure. The main body of the workshop set off from Dunkirk on the morning of 6th May, on the 180 mile (290 km) road journey south to the area of Pacy-sur-Eure, halting at Blangy-sur-Bresle, between Dieppe and Amiens, overnight, before moving on the next morning and crossing the Seine at Vernon. They would reach their destination in the late afternoon, billeting with their advance party at Bréval, to the southeast of Pacy. The workshop itself would be established in a large barn on 8th May, with the first two Infantry Tank Mk. I's of 4 RTR being submitted for repair the ensuing day. In the meantime a road party of 94 men from 7 RTR had departed for Dover on the morning of 6th May, while the battalion's second personnel train had left an hour before midnight, the loading of the two vehicle trains at Aldershot also being completed on this date. The next morning, 7th May, both vehicle trains and the last personnel train started off for Dover, the regimental war diary affirming that the "Unit [is] now entirely en route for B.E.F.", although a residue had been left behind to tidy up. The last personnel train arrived at Dover after dawn on 8th May, where they had breakfast before boarding a train ferry bound for Dunkirk, with the balance of the 'A' vehicles, transport vehicles and personnel having already departed for France. The battalion arrived at Dunkirk during the evening, their commanding officer, Lieutenant-Colonel Hector Heyland, setting off immediately with his second-in-command and his adjutant to Domart-en-Ponthieu by road, this having recently been vacated by 4 RTR. The rest of the unit personnel, as well as their tanks and vehicles, would continue by rail to Doullens on 9th May, this being thirteen miles (21 km) to the northeast of Domart. From here they detrained and dispersed to billeting areas around Domart itself.

That very evening the German Wehrmacht were preparing to launch their *Fall Gelb* (Case Yellow) offensive against France and the Low Countries. During the night and the morning of 10th May, the most northerly of their two army groups, Heeresgruppe B (Army Group B), moved into Belgium, Luxembourg and the Netherlands, being assisted by surprise landings by airborne troops. The initial response of 7 RTR at Domart-en-Ponthieu was to order sentries to be posted around the nearby villages to protect their billeting areas from infiltration, there being a particular concern about enemy parachutists. The entrances to the villages were to be covered by small arms fire, the battalion's Operation Instruction No. 1 stating that "The fire may be provided by Light Tanks and Infantry Tanks Mk. I" The battalion were then put on six hours' notice to move to the forward areas, it being laid down that any move would occur in three phases, the first of these being the movement of their tracked vehicles to selected railway stations for forward loading. This would be followed by the move of their supporting 'B' vehicles by road, these carrying petrol, ammunition, spare crews and other supplies. The third and final phase was to be the organisation of the personnel of the rear party, who were to remain at Domart until receiving further orders. The battalion had evidently brought their Fowler mine ploughs with them to France, as it was stipulated that on their move forwards, "Coulter attachments will *not* be taken." The move to the forward areas would be a preliminary to the enactment of the Dyle Plan (or Plan 'D') in which the BEF would accompany the French *groupe d'armées* No. 1 (1st Army Group) northwards to a pre-prepared defensive line along the River Dyle in Belgium. This was to counter the expected German line of attack into Belgium, to which the enemy were so far following faithfully. Momentous events were simultaneously happening in London, as on 10th May the First Lord of the Admiralty, Winston Churchill, became Prime Minister following the resignation of Neville Chamberlain, this itself being prompted by the debacle of the Allied expedition to Norway, which although still ongoing, had already witnessed a major evacuation.

The groupe d'armées No. 1 was commanded by *général d'armée* Gaston Billotte, and consisted of the *1re, 2e* and *9e armées*) (1st, 2nd, and 9th armies). The Dyle Line ran from Sedan, just south of the Belgian border, to Antwerp in the north, and comprised a number of waterways, starting with the Meuse (Maas) running from Sedan to Namur in Belgium, seventy miles (110 km) to the north. There was no natural barrier between Namur and Wavre, another 25 miles (40 km) to the northwest, this sector being known as the Gembloux gap after the small town that sat in the middle of it. However from Wavre northward to Louvain (Leuven) the Dyle itself provided the protection for the eastern approaches to Brussels, while the front from Louvain to Antwerp incorporated various canalised rivers. The French General Staff at GQG expected the main German attack to strike between Namur and Antwerp, along a front of approximately seventy miles (110 km), and so had concentrated their main force here. The French 1re armée with its eight infantry and two light mechanised divisions (*2e* and *3e divisions légères mécaniques*, DLM's) was to be located on the right (southern) flank of this line, ostensibly covering the Gembloux gap, while to their north the BEF were to hold the central portion of the line from Wavre to Louvain. The nine divisions of the BEF's three corps were to be deployed in depth with three on the front line, the reconnaissance battalions forming a screen ahead of them. On the left flank of the BEF the Belgians were to cover the remainder of the line up to Antwerp, although in contrast to the French and British advancing to the Dyle, the Belgians would fall back to it as part of their anticipated delaying action from the frontier. As such, they intended to initially fight on the Albert Canal from Antwerp to the Meuse, and along the line of the Meuse from Liège to Namur, to provide time for the British and French to reach the Dyle.

Behind the Dyle the independent French 7e armée (7th Army) were to advance to the mouth of the River Escaut (Scheldt) at Antwerp to cover the Belgian left flank with their six infantry divisions and single light armoured division, 1re division légèr mécanique (1re DLM). Below the groupe d'armées No. 1 the stretch from Namur southwards to Sedan, and then southeast to Longwy near the border with Luxembourg, was to be held by the 2e and 9e armées, the GQG reasoning that the River Meuse and the extensive Ardennes forest provided an insuperable barrier to an armoured breakthrough in that area. The 2e armée were to hold a forty mile (65 km) line between Longwy and Sedan, while the 9e armée were to occupy a fifty mile (80 km) sector between Sedan and Namur. Together these had twelve infantry divisions, and a number of cavalry formations, with both armies having received a smaller scale of equipment and reinforcements than the armies on the Dyle. While the 1re, 2e and 9e armées would be commanded by *général* Billotte, both the BEF and 7e armée would be under the direct command of his superior, *général* Alphonse Georges, who oversaw the whole of the French north-east theatre of operations, this including the groupe d'armées No. 2 on the Maginot Line, which covered the border with Germany. Georges had access to a reserve of only thirteen divisions, which were mainly located towards the groupe d'armées No. 2.

During the evening, 7 RTR were visited by their brigade commander, Douglas Pratt, their diary remarking that there were "No incidents but the air charged with forbiding [*sic*]." Nevertheless Plan 'D' had commenced smoothly, the first British units arriving on the Dyle that night, these being reconnaissance battalions equipped with armoured cars and light tanks. On 11th May the battalion's reconnaissance officer, Captain John "Jock" Holden, travelled to Brussels, which was to be the 1st Army Tank Brigade's ultimate destination under Plan 'D'. Here he was to select detraining stations for the brigade on behalf of GHQ(AFV), the two stations chosen being at Sint-Agatha-Berchem and Halle, to the west and southwest of the city. The unit's first (*i.e.* immediate) reinforcements were to head in the opposite direction, to the Château De Gastines at Fougeré, just to the southwest of Le Mans, which was the location of the RAC's Base Supply Depot. At Bueil, in the vicinity of Pacy-sur-Eure, 4 RTR were cautioned that they were also to move in accordance with Plan 'D'. This was followed the next morning, 12th May, by a warning order stating that the 1st Army Tank Brigade Headquarters and a road party from 4 RTR were to depart from Beuil for Breteuil, seventy miles (110 km) northeast of Pacy and twenty miles (30 km) south of Amiens at 1400 hours that afternoon. This was crystalised with the 1st Army Tank Brigade's Operation Order No. 1, which clarified that the column was to include the brigade's headquarters, its RASC supply company, its field ambulance company and its workshops, as well as the road party of 4 RTR. On reaching Essertaux, to the north of Breteuil, in the early evening, the subsequent brigade Operation Order No. 2 was issued to move on to Orchies, a further 90 miles (150 km) towards Brussels, the next day. 7 RTR had also received Operation Order No. 2, which compelled them to send their road party to Orchies to join the rest of the brigade.

The Belgian defence on the Albert Canal had been unexpectedly compromised by the seizure of the fortress of Eben-Emael, and three canal bridges on the western side of Maastricht, by German airborne troops, this precipitating the early collapse of Belgian resistance on the frontier. This in turn had allowed the XVI *Panzerkorps* (Tank Corps) of Heeresgruppe B to arrive at the Gembloux gap on 12th May, before the 1re armée had managed to dig in. The French high command considered this to be the central point

of the German offensive, opening up the route to Paris, and in order to frustrate this move, the 2e and 3e divisions légères mécaniques attempted to intercept the German armour at Hannut, to the east of Gembloux. The result was an enormous, though somewhat indecisive, tank battle that lasted until the following day, 13th May, which nevertheless granted the French 1e armée sufficient time to settle. The British build-up on their section of the Dyle however proceeded with relatively little hindrance. The 1st Army Tank Brigade road party's move to Orchies was accomplished on 13th May, with 7 RTR billeting for the evening in Orchies itself, while 4 RTR billeted at nearby Landas. Operation Order No. 3 was issued that day, directing the brigade road party to Halle, a few miles to the southwest of Brussels, with Brigadier Pratt proceeding across the frontier into Belgium with a reconnaissance party. Back at Beuil, 4 RTR's tank party was entrained on two trains destined for Halle, with 25 Infantry Tank Mk. I's being allocated to each train. Four cavalry carriers and a unit fitters' vehicle were also allocated to each train, the first train being loaded with six Light Tank Mk. VI B's, three of which belonged to the brigade headquarters, while the second train was to carry four Light tanks. All the tanks were loaded on the train facing the engine, the train departing on time just after midday. The brigade workshop had left behind a rear party to continue work on the pair of Infantry Tank Mk. I's under repair, one of these being completed and returned to 4 RTR prior to its entrainment, and the second being handed over to a detachment from the RAC Base Depot for further work.

While the French 1e armée had been resisting the armoured thrusts towards Gembloux, to the southeast their 9e armée had enjoyed less success establishing themselves on the Meuse, their forward elements having withdrawn to the west side of that river. This had allowed German vanguards to establish small bridgeheads over the Meuse near the towns of Sedan and Dinant, while the seven panzer divisions of the powerful *Heeresgruppe A* (Army Group A) had passed through the Ardennes into France and reached its eastern bank. The speed of the subsequent attack, combined with its unprecedented level of close air support, initiated a panic in the French defensive positions behind the Meuse. During the morning of 14th May, the Germans captured the key defensive position at the Bulson ridge, six miles (10 km) behind the river, this allowing *1.* and *2. Panzer-Division* (1st and 2nd Armoured Divisions) to thrust westwards along the Somme valley and then northwest into the rear of the groupe d'armées No. 1, while 10. Panzer-Division and the *Infanterie-Regiment „Großdeutschland"* were ordered south across the plateau in order to engage the French armoured forces amassing in the town of Stonne.

Far to the rear, 7 RTR entrained their tanks at Doullens on 14th May, their three companies, 'A', 'B', and 'D', being allotted a train each. Also on this date, the road parties of the 1st Army Tank Brigade and 4 RTR moved from the Orchies area along the increasingly congested roads to a harbour in the Forêt de Soignes, an extensive woodland on the southeast periphery of Brussels. The brigade workshop did not travel quite so far, its main body settling at Mussain in the Bois de Stéhoux, southwest of Halle, where it set up in a barn. The brigade itself was to be located east of the line of the River Senne (Zenne), a tributary of the Dyle which runs through Brussels itself, with 7 RTR having been allotted the left (northern) flank and 4 RTR the right (southern) one. In the evening the commander of 4 RTR, Lieutenant-Colonel Fitzmaurice, took a group to the railway station at Halle to meet their rail parties, which they learned would be late in arriving. Indeed the two trains did not turn up until early the following morning, 15th May, the tanks being immediately unloaded and stored under tree cover just to the east of Halle. They were to temporarily remain here until darkness permitted their onward movement to the battalion's allocated assembly area. Further to the north, the trains carrying the tanks of 7 RTR arrived at Sint-Agatha-Berchem later that morning, although the train carrying their 'D' company was redirected to Halle. The tanks of 'A' and 'B' companies were unloaded and harboured near the station at Sint-Agatha-Berchem, the intention once again being to move them to the battalion assembly area when darkness fell. In the meantime Lieutenant-Colonel Fitzmaurice of 4 RTR made contact with the headquarters of the 2nd Infantry Division of 1st Corps, this corps having been authorised by Lord Gort to take command of the 1st Army Tank Brigade if communications with GHQ failed. The instructions to move after nightfall were soon countermanded, as before midday the brigade headquarters ordered 4 RTR to collect their tanks immediately and head to their allotted area. 7 RTR were similarly permitted to undertake a daylight move, reaching their designated assembly area by midnight, their passage being impeded by the burgeoning stream of refugees decamping from Brussels. During the evening the two battalions were ordered to relocate further forwards into the Forêt de Soignes, with 4 RTR now holding the left flank, and 7 RTR the right one.

The French 1e armée were continuing to resist attempts by Heeresgruppe B to penetrate the Gembloux gap, successfully holding back a dedicated thrust by the German IV and XVI corps over the 14th and 15th May. The British had also repelled attacks by the German XI an IV Corps on Louvain and Wavre, and maintained their positions on the Dyle. However the crisis south of Sedan was deepening, with *10. Panzer-Division* and the *Großdeutschland* regiment engaging the French at Stonne on 15th May, including the heavy

A second production batch Infantry Tank Mk. I Glory *of 'C' Squadron, 7 RTR. According to the details provided with the photograph it had been abandoned in Belgium, making it one of the first tanks discarded by 1st Army Tank Brigade. Note that it is mounting the winch and pulleys for the Fowler mine plough.* *(Robert Gregory Collection)*

Char B1 *bis* tanks of the *3e division cuirassée* (3 DCr), this leading to a series of ferocious battles to capture the town. Concurrently, the westward thrust of 1. and 2. Panzer-Division enabled their motorized infantry to fight through the reinforcing French 6e armée in their assembly area west of Sedan. This exposed the southern flank of the French 9e armée, prompting large portions of it to surrender. A further bridgehead had been forced over the Meuse at Montherm by 6. and 8. Panzer-Division, allowing them to surround and destroy the French *102e division d'infanterie de forteresse* (102nd Fortress Infantry Division). By this time it was dawning on the French that the thrust by Heeresgruppe A across the Meuse was the main axis of the German invasion, with the attack through Belgium by Heeresgruppe B being a subsidiary lure. This realisation included the recognition that the Allied armies in Belgium were about to be cut off and encircled in a pocket against the Channel coast. The result was a collapse in French morale, with their Prime Minister, Paul Reynaud, telephoning Winston Churchill to declare that the Allies had been defeated. On 16th May, Churchill flew to Paris to discover that the French government was preparing an evacuation of the capital, while the French Chief of Staff, Maurice Gamelin, informed him that there was no longer a strategic reserve to counter the German offensive.

The progress of Heeresgruppe A from Sedan had prompted the French 1e armée to withdraw from the Gembloux sector during the evening of 15th May in order to protect its right flank and rear, with the British 1st Corps having to pull its right flank from Wavre to a line along the River Lasne in order to maintain contact with them. On 16th May the 1st Army Tank Brigade's Operation Order No. 4 was issued, detailing their role as countering any penetration by the Germans through 1st Corps' line on the Dyle and Lasne, with an alternative counter-attacking role also being possible. However earlier that morning Lord Gort had learned that it was *général* Billotte's intention to withdraw the 1st Army, the BEF and the Belgian Army to the River Escaut, roughly fifty miles (80 km) to the rear. This was to be carried out on successive nights in three stages, the first being a move to the Senne, the second to the River Dendre, and the last to the Escaut itself.

By the early afternoon 1st Corps had ordered a general withdrawal, with the 1st Army Tank Brigade being instructed to retire by road and rail to Willems, just inside the French border near Lille, and behind the Escaut at Tournai. The initial move for 4 RTR was to be 25 miles (40 km) west by road only to Bassilly, this being accomplished two hours before midnight. GHQ had arranged with the Belgians for as many railway flat trucks to be collected near Bassilly for the evacuation of 1st Army Tank Brigade, although the local British railway representatives reported that locomotives were scarce and crews non-existent, and so GHQ gave orders for British crews to man the engines. 7 RTR were instructed to entrain at Enghien, east of Bassilly, although the battalion's reconnaissance officer, Jock Holden, on visiting the station at Enghien, would report that the railway in this vicinity was unusable, presumably due to bombing. Holden nonetheless contacted the BEF's Movement Control at Grammont (Geraardsbergen) to the north in order to ascertain if the situation was improved further down the line. The battalion withdrew from the Forêt de Soignes during the afternoon, leaving two sections (of three tanks each) under Major George Parkes in the area of L'Ermite, near Waterloo, to the south of Brussels, these being detailed to cover the withdrawal of the infantry of 1st Corps. On reaching Enghien, the tanks were ordered to halt and await instructions for entraining.

Meanwhile the 1st Army Tank Brigade Workshop had made its first attempts at recovery, with a disabled Infantry Tank Mk. II having been collected from a location four miles (6 km) east of Enghien, and an Infantry Tank Mk. I from Halle. However the workshop noted that their recovery efforts were being hampered by the fact that a shortage of heavy vehicles had led to the ordnance stores for the two tank types having to be carried on their three recovery trailers. These in turn were towed by their trio of Scammell recovery tractors, which were thereby prevented from towing any disabled tanks, this being the standard method of recovery. The ordnance stores had been brought over by 7 RTR for the establishment of a Forward Ordnance Depot (FOD), however the constant movement of the brigade had prevented this from being undertaken. At this time, neither the BEF's GHQ at Arras, nor Gort's forward Command Post at Renaix (Ronse) to the northeast of Tournai, had any solid information on the extent of the German penetration from Sedan, nor of any prospective French attempt to counter it. Indeed, the bifurcation of intelligence assets between Arras and Renaix accentuated the British strategic blindness. However, Gort had received instructions from *général* Georges to constitute a new southern boundary for the BEF which was to run back from Maulde on the Escaut through Orchies and Raches to Hénin-Liétard, five miles (8 km) east of Lens. This would leave Arras, and thus GHQ, outside of the British zone of responsibility, although Gort was nonetheless determined to hold that town. During the night a conference was held by 1st Army Tank Brigade, during which it was concluded that the entraining of tanks would be impracticable due to the continued German bombing of the railway line, and so the withdrawal would have to continue by road. As such, at 0130 hours on the morning of 17th May, the commander of 4 RTR, James Fitzmaurice, was informed by the Brigade Major, Bernard Cracroft, that there would be no trains available, and that the battalion should be prepared to carry on to Willems by road, a similar message no doubt being communicated to 7 RTR. The brigade workshop would also be instructed to withdraw westwards, although in their case to Tressin, a few miles southwest of Willems. In a sign of events to come, they would have to abandon the two tanks they had just recovered, which could only be further disabled with the resources available, rather than being destroyed.

Both 4 RTR and 7 RTR recommenced the road journey well before dawn, although on passing Ath, thirteen miles (21 km) further down the line from Enghien, they were ordered to turn back and concentrate at Enghien. This order had come from 1st Corps, the purpose being to cover their own withdrawal, the brigade returning to Enghien and adopting defensive positions, as well as sending out reconnaissance patrols. Meanwhile, according to the estimates of GHQ, by 0800 hours seventy-two railway flats had belatedly been assembled in three rakes (*i.e.* coupled rows) at Bassilly for the evacuation of the entire 1st Army Tank Brigade. Early in the afternoon the orders changed again, and the brigade were allowed to retire to Ath and spend the night in the area of Moulbaix. However, at around 1500 hours the brigade was visited by Brigadier Vyvyan Pope from GHQ, who ordered them to withdraw immediately to the vicinity of Orchies, a further fourteen miles (23 km) south of Willems. Pope, who had previously been the BGS of 1st Corps, had taken over from Justice Tilly as BAFV at GHQ on 10th May, his nominally advisory position having been overridden by the increasingly cataclysmic turn of events. Orchies was to be the headquarters of Macforce, under Major-General Frank Mason-MacFarlane, which had been formed that day by GHQ to defend the southern flank of the BEF against the German columns that were now moving northwest from Cambrai. The 1st Army Tank Brigade were to join Macforce alongside the 127th Infantry Brigade and accompanying artillery, engineers and pioneers. As the distance of the march was now increasing, Pope would make another attempt to provide railway transport for the brigade, this task then being taken up with gusto by another GHQ staff officer, Major J.B. Bunting. Pope had not been able to find any of the trains that

Another tank, Gourock, *mounting the winch drive for the Fowler mine plough. Note how the engine compartment roof has been lifted to give access to the nearside of the engine and gearbox, raising the suspicion that a broken gear selector lever is the cause of the breakdown. The number "1875" on the offside mudguard is the unit serial number for 7 RTR.* (Private Collection)

were supposed to have been ready at Bassilly, these seemingly having already been claimed, but had given a note to the French *Commissaire* at Ath asking for at least twenty, and preferably eighty, railway flats to move the brigade. Meanwhile Bunting on his own initiative went up and down the line, which was apparently clear of damage, attempting to find any appropriate rolling stock. He eventually discovered 29 twenty-tonne flats on a loop line, and arranged with the French to send them on to Chapelle-à-Wattines, a further six miles (10 km) west from Ath. Bunting then returned to Ath and met the commander and adjutant of one of the two tank battalions, his report recording that:

> Lt. Co. [*sic*] was definitely of the opinion that the Tanks were better proceeding as they were bearing in mind the uncertainty of rail travel. The Adjutant thought they would not stand up to the road journey.

After this, Bunting drove to the GHQ Command Post, now at Wahagnies, and spoke to the Assistant Director of Transport, who decided that the best option was for the tanks to proceed by road to Orchies, where "tactical trains" for any subsequent operational moves were being prepared for them. In the early hours of 18th May the 1st Army Tank Brigade issued a second Operation Order No. 4, the repeat number demonstrating the level of confusion that was prevalent within the headquarters. This instructed the brigade, less its RASC company and the workshop, to move that day to an area between Orchies and Douai, which was forty miles (65 km) southwest of Moulbaix. The journey was to be conducted in four groups, the leading group ('A') being composed of the Light tanks, the Infantry Tank Mk. II's, the carriers, and the wheeled vehicles in that order. The second group ('B') was to comprise the Infantry Tank Mk. I's, while the third ('C') was to consist of the vehicles of the brigade headquarters, and the fourth ('D') the field ambulances. Of significance was that the first and third groups ('A' and 'C') were instructed to travel at the speed of 8 miles in the hour (mih; 12 km/h), while the second group ('B') was to travel at only three miles (5 km) in the hour. This meant that the Infantry Tank Mk. II's would be moving faster than the Mk. I's, which reflected the higher maximum speed of the A12 in comparison to the A11. The field ambulance were allowed to set their pace at their own discretion. The density of the brigade column was to be ten vehicles to the mile (vtm; ca. six vehicles to the kilometre), with each unit sending a reconnaissance

party ahead to establish their separate billeting areas. The brigade workshop was to follow on the tail of the column, and establish their workshop at Pont-à-Marcq, to the northwest of Orchies. The constant setting up and dismantling of the workshop did of course mean that very little heavy recovery and repair work could be undertaken, their successful efforts so far being confined to the occasional wheeled 'B' vehicle. In their diary the workshop did however give a comprehensive account of the obstacles encountered in all the brigade's moves, these including aerial attack, the clogging of the roads by refugees, and the regular alarms over the presence of fifth columnists and parachutists.

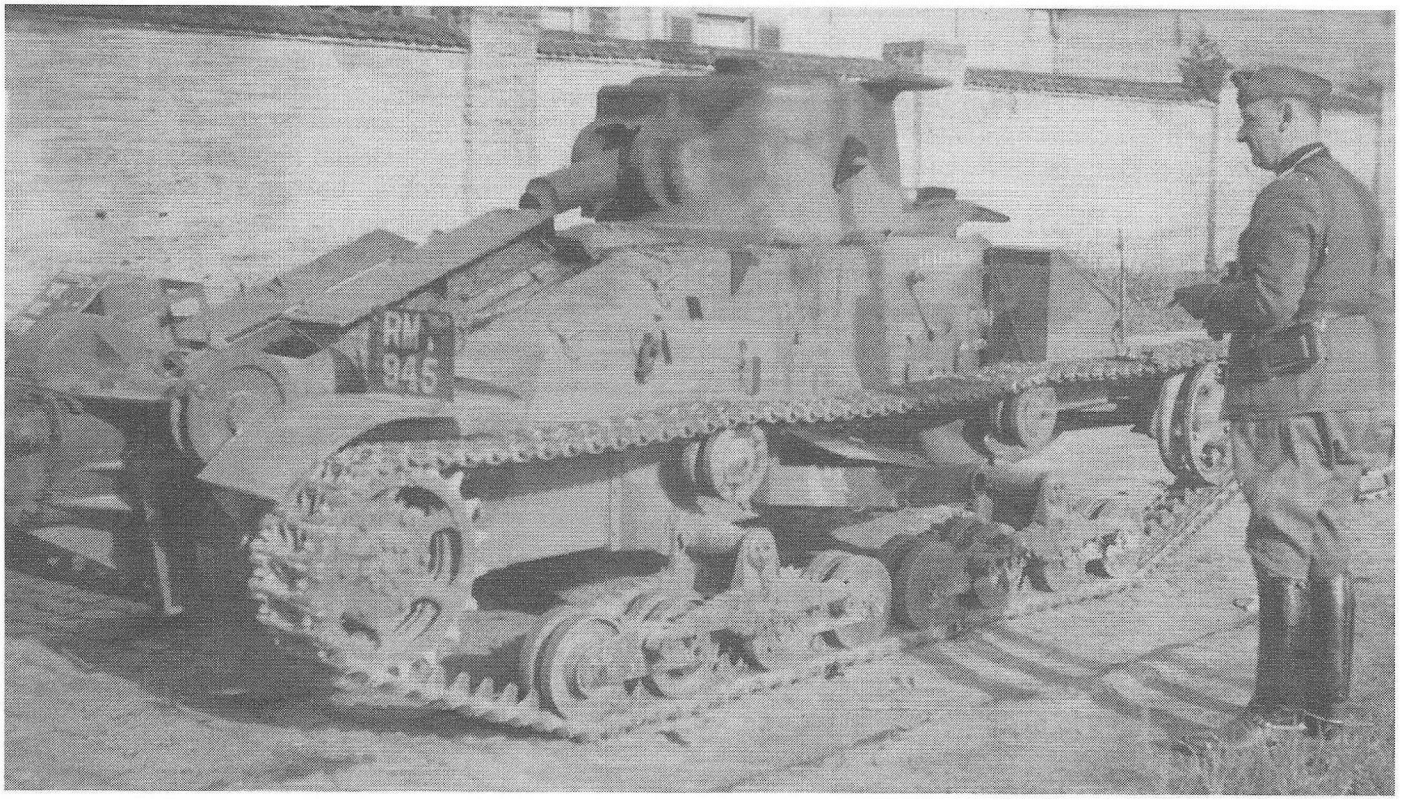
4 RTR received Operation Order No. 4 at 0500 hours, and departed from Moulbaix two hours later, while in the middle of the afternoon they received a signal message from the brigade headquarters to harbour in the area of Cysoing, nine miles (15 km) north of Orchies. The brigade headquarters was itself to be billeted at Genech, midway between these two towns, while 7 RTR was to stay at Cobrieux, just to the north of Genech. 7 RTR, however, had not received Operation Order No. 4 at all, and had withdrawn on their own initiative in company groups to the French frontier through a mass of refugees, bombs and bomb wreckage, with no contact being made with the brigade headquarters all day. By the beginning of the evening 4 RTR's 'B' echelon had arrived at Cysoing, although the battalion were told to halt their tanks west of Mouchin, which was a short distance east of Genech, until nightfall. Lieutenant-Colonel Fitzmaurice set off to the brigade headquarters, which had relocated from Genech to Nomain, just north of Orchies, at 2130 hours, and received instructions from Bernard Cracroft on where to place the battalion's tanks for the night. This would enable them to function as pillboxes, so as to prevent any enemy penetration between Orchies and Mouchin, the companies moving out on this task shortly after midnight. In the meantime 7 RTR had belatedly made contact with the brigade headquarters and been issued Operation Order No. 4, which was "as usual unworkable", presumably because it was too late for them to implement it. Otherwise they declared themselves to be "very depressed and all very tired", managing to commence their sleep at 0500 hours the following morning. While at Pont-à-Marcq, the brigade workshop managed to recover two more tanks, these being an Infantry Tank Mk. I and a Mk. II which had broken down during the move to Orchies. Nonetheless, on the evening of 18th May the main body of the workshop were moving on again, this time north to Tressin, just to the east of Lille. They arrived at Tressin in the early hours of 19th May and set up in the local Château Hem, where they commenced work by replacing the engine on the Infantry Tank Mk. I and repairing the radiator and fuel system of the Mk. II. Although communications with the brigade headquarters were described as "difficult and uncertain" they gained the notion that they would be able to remain in this location for four days.

Meanwhile at midnight *général* Billotte had visited Lord Gort's command post at Wahagnies to discuss the overall situation of the Allied armies. Billotte did not give an encouraging estimate of the attempts to restore the situation in the sector of the French 9^{e} armée west of Sedan, leaving Gort to ponder how to respond if the gap opened up by the German Heeresgruppe A could not be closed. There were only two potential options, both of which were unpalatable. The first was a withdrawal south to the Somme in order to preserve the lines of communication with the BEF's rear maintenance area, thus leaving the Belgians to their fate. The other option was a retreat to the coast followed by evacuation, thereby abandoning the French, as well as a great quantity of stores and equipment. However on being presented with a map by Billotte that indicated there were no French forces between the panzer divisions of Heeresgruppe A and the Channel coast, Gort surmised that evacuation was the only practicable option. The following day his Chief of Staff, Henry Pownall, would accordingly telephone the Director of Military Operations and Plans at the War Office, Major-General Richard Dewing, and explain the situation. During the afternoon of 19th May, both 4 and 7 RTR contributed a combined seven Light tanks to patrol south of the River Scarpe, six miles (10 km) southeast of Orchies, towards Valenciennes. This was undertaken in compliance with the brigade's Instruction No. 1, the purpose being to gain information on the enemy, who were reported to be moving northwestwards from the Forêt de Mormal, a dozen miles (20 km) further southeast of Valenciennes. During the evening the two battalions received the brigade's Operation Order No. 5, which formalised their role in assisting in the defence of the Scarpe, with the Infantry Tank Mk. II's of 7 RTR being ready to counter any enemy tank penetration over the river. Nevertheless the Light tank patrol reported back that Valenciennes was clear of the enemy, before being sent out again before dawn the next morning. During the night the 50th Northumbrian Division, located fifteen miles (25 km) northwest of Orchies at Loos, were informed that they were to proceed twenty miles (30 km) south to Vimy, in order to perform "offensive action" near the town of Arras. This formation was commanded by Douglas Pratt's old superior within MGO5, Major-General Giffard Le Quesne Martel, its advanced headquarters having only just arrived at Loos following a brief stay at Herseaux, just over the Belgian border, after partaking in the BEF's withdrawal to the Escaut. The 50th Division had initially been ordered to cover a 25 mile (40 km) section of the Scarpe Canal between Râches and Béthune, although the alleged "improved situation" had prompted their deployment further south.

It was originally intended that only two of the division's three infantry brigades would move to Vimy, these being the 25th and 150th brigades, with the 151st Brigade remaining on the Scarpe Canal. However, the unavailability of troop carrying transport for the 25th Brigade led to them switching places with the 151st Brigade, who would now follow the 150th Brigade south. Further to the south the situation was in fact becoming critical, with leading elements of the German Heeresgruppe A reaching the Canal Du Nord, which intersected the road from Cambrai to Arras. This was only fifteen miles (25 km) from Arras itself, and fifty miles (80 km) from Abbeville on the coast. As such, the BEF's southern flank was in danger of being fully exposed and having its lines of communication to the stores depots below the Somme cut. The 50th Division's advanced headquarters reached Vimy at 1030 hours on the morning of 20th May, with Martel himself arriving at noon. He would then visit *lieutenant général* René Prioux, the commander of the *corps de Cavalerie*, whose force was located on the River Scarpe east of Arras. However the move of the 151st Brigade had been suspended on the orders of GHQ, until the 25th Brigade were in position on the Scarpe Canal. As the advance elements of the German 7. Panzer-Division had already made some probing attacks against Arras, the divisional motorcycle battalion, the 4th Royal Northumberland Fusiliers, were ordered to organise a protecting screen on Vimy Ridge, which was six miles (10 km) north of Arras, until the arrival of the 150th Brigade.

In the meantime, General Edmund Ironside, who had replaced Lord Gort as CIGS following the latter's appointment as commander of the BEF, had flown to Belgium to meet Gort at his forward Command Post at Wahignies. This was on the northeastern outskirts of the town of Lens, where the headquarters of *général* Billotte was also located. The BEF were at this time holding a thirty mile section of the front along the River Escaut against the German Heeresgruppe B, with the Belgian Army to their left (north) and the French 1^{e} armée to their right (south). However, a gap in the French line had opened up in front of Heeresgruppe A in the vicinity of the Canal du Nord, this opening having only been partially filled by two British Territorial formations, the 12th (Eastern) Infantry Division and the 23rd (Northumbrian) Infantry Division. These had been brought to France principally for labouring duties, and were neither fully trained nor equipped as fighting divisions, each having half the strength of a full division. As such, they had no dedicated artillery, possessed only skeleton signals and administrative units, and

Side view of Gourock, *showing the robust construction of the production winch gear housing. Note the pin on the perimeter of the offside pulley, which provided the attachment point for the offside lifting chain of the plough frame. Also visible is the bracket for the pivot pin of the frame, onto which the inlet ventilation blanking plate has fallen and come to rest. The later design of aerial bracket has been fitted, this not incorporating the clamping groove for the blanking plate, which was stowed lower on the hull on second production batch machines.* *(Private Collection)*



were on a reduced scale for armament and transport. Ironside arrived at Gort's Command Post at 0800 hours, carrying "Order A" from the War Cabinet, this requesting that the BEF move southwards to Amiens and position themselves on the left of the French Army, thus allowing the Belgian Army to extract themselves from the Escaut between the BEF and the coast. Gort considered this course impracticable, as that morning the Germans had started crossing the Canal du Nord in force, turning the right (southern) flank of the BEF. Short of a major intervention by the French, Gort saw his only possible course of action as a withdrawal northwards, this to be preceded by a limited operation towards Arras to support its garrison and cut off German communications to the east. At 0900 hours Major-General Harold Franklyn, the commander of the 5th Infantry Division, was summoned to Wahagnies, where he was verbally instructed by Gort to command an improvised formation to be known as Frankforce. As well as comprising his own 5th Division, Frankforce was to incorporate the 50th Division and the 1st Army Tank Brigade, these being the only regular formations that were not already committed against Heeresgruppe B on the Escaut. Also included in Frankforce were two scratch formations, these being Petreforce and Lumsdenforce. Petreforce, under Major-General Roderic Petre, included the makeshift garrison at Arras as well as elements of the 12th and the 23rd divisions, these latter being expected to bear the brunt of the effort to prevent the panzers of Heeresgruppe A reaching the Channel coast. Lumsdenforce, commanded by Lieutenant-Colonel Herbert Lumsden, mainly consisted of the armoured cars of the 12th Lancers, as well as some Light tanks, this being tasked with performing reconnaissance to the south of Arras. Gort's instructions to Franklyn were summarised in written form by the recently appointed Deputy Chief of Staff (DCGS), Major-General Oliver Leese, thus:

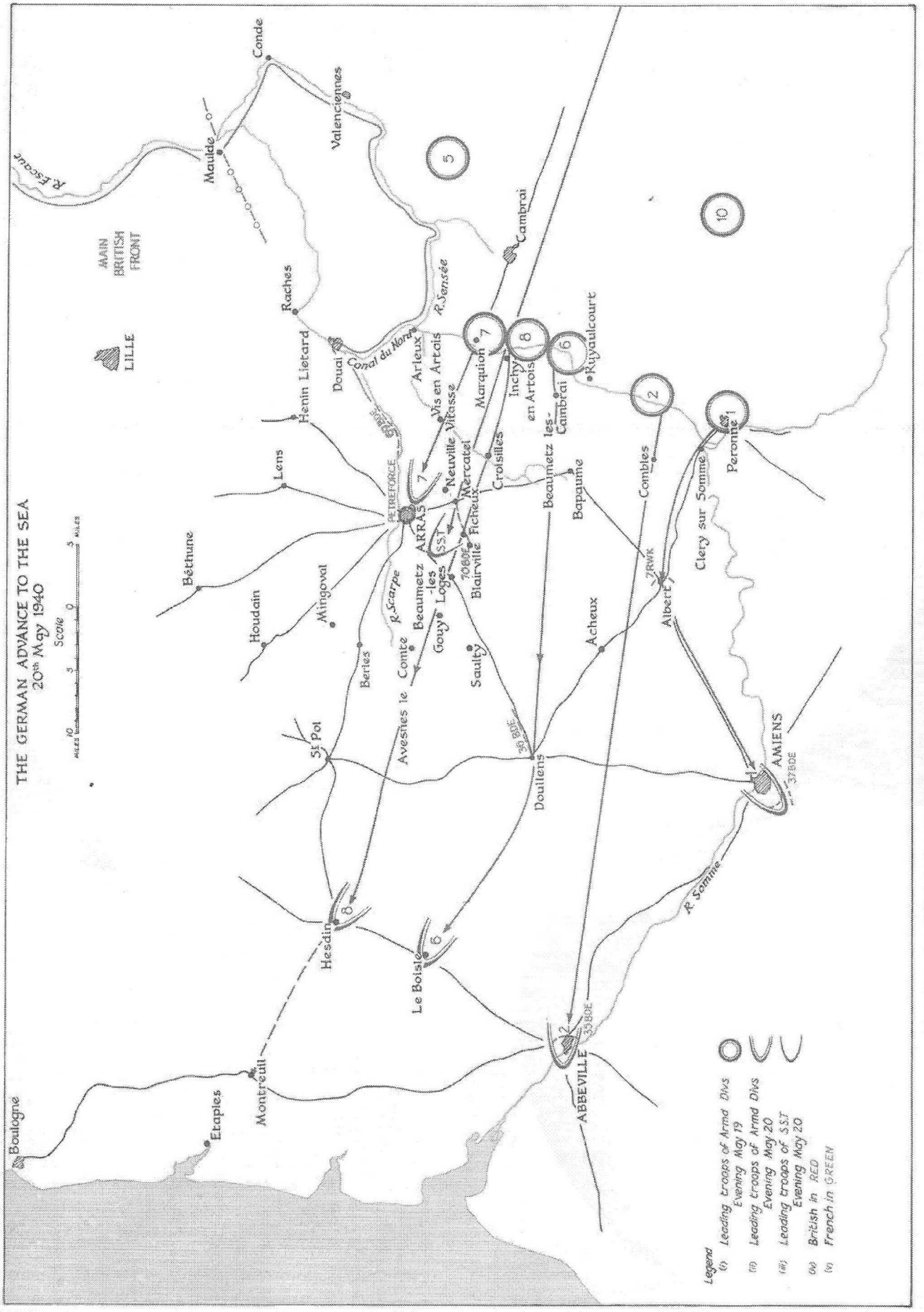
> Your role is:
>
> (a) To support the garrison [in Arras] and block the roads to the South of ARRAS thus cutting off the German communications with the East.
>
> (b) To occupy the line of the R. SCARPE on the East of ARRAS. You should gain contact by patrols with the French on your left."

The achievement of (a) would require a sweeping attack around the south of Arras to seal off the main roads to Doullens, Bapaume and Cambrai. GHQ and all other essential administrative elements had evacuated Arras the previous day, the town now being held in order to firm up the BEF's southern flank. The French force alluded to at (b) was the 3^{e} division légère mécanique (3^{e} DLM), who were positioned along the River Scarpe to the east of Arras, these being supported by the British 69th Infantry Brigade. The DCGS would additionally assure Franklyn that:

> For your fighter and bomber support and air reconnaissance you will either state your requirements to us or to the A.O.C. the Air Component. Every endeavour will be made to obtain all the bomber and fighter support available.

The Air Officer Commanding for the BEF's Air Component was Air Vice-Marshal Charles Blount, the Air Component being the Royal Air Force command in France that had been directly allocated to supporting the BEF. The other RAF command in the theatre was the Advanced Air Striking Force (AASF), which had been initially intended for strategic operations over Germany, although the deteriorating situation had meant that it had been thrown against the German ground forces, with generally catastrophic results. The high loss rate of both the Air Component and the AASF had prompted the RAF's umbrella organisation, British Air Forces France (BAFF), to appeal to the Air Ministry and War Cabinet for reinforcements, which after a great deal of demurring had reluctantly been provided. However, by this time communications between the BAFF, which was located south of the German incursion, and the Air Component, mainly located north of it, had been severed. As a result, the Air Component was now being directed by Lord Gort in concert with the Air Ministry, although as its airfields were being overrun by the enemy, it was already in the process of being evacuated back to England.

In the middle of the morning Vyvyan Pope visited 7 RTR and issued orders for their reconnaissance officer (Captain Holden) to proceed to Vimy and contact 'Q' Martel. Pope then moved on to the 1st Army Tank Brigade's headquarters, the result being that in the early afternoon the brigade issued their Movement Order No. 1 for the move to Vimy Ridge, which was approximately 25 miles (40 km) west of Orchies. The column would consist of eight groups, led by the vehicles of the brigade headquarters, followed in sequence by those of 7 RTR and 4 RTR, and then the Light tanks and carriers of 7 RTR and 4 RTR, these all to progress at 15 miles (25 km) in the hour (mih). The sixth group was to consist of the Infantry Tank Mk. II's of 7 RTR, once again travelling at 8 miles (13 km) in the hour, while the last two groups were to be the Infantry Tank Mk. I's of 7 RTR and 4 RTR, these travelling at 3 miles (5 km) in the hour. The instruction recorded that by this time 7 RTR were down to 17 Mk. II and 24 Mk. I tanks, while 4 RTR had only 38 Mk. I's, thus giving the brigade 79 Infantry tanks from their originally available 100. However, the figure for the Mk. II's was likely for runners only, and did not reflect



Map from the Official History showing the progress of Heeresgruppe A to the Channel coast.

the number actually on hand. It was also stipulated that the Mk. II tanks could halt for an hour after every two hours of running, while the Mk. I tanks could halt for 15 minutes before even hours, *i.e.* 1800, 2000 hours etc. This reflected the heavier maintenance requirement of the A12's, the longer rest also ensuring that they did not get too far ahead of the A11's during the march. However, the principle of running the Infantry Tank Mk. II's at a faster pace than the Mk. I's was an unwise one, as it was more likely to induce wear on their automotive components. The spacing of the column was once again ten vehicles per mile (six vehicles per kilometre), the rear of the column being brought up by the vehicles of the unit fitters. 5th Division, who were located at Seclin, fourteen miles (23 km) northwest of Orchies, would move off to Vimy during the afternoon, establishing their headquarters in the village alongside that of the 50th Division. At around 1600 hours, Harold Franklyn would visit René Prioux at Arras, and arrange to relieve his force (*i.e.* 3e DLM) along the Scarpe so that they could move west and cover the right flank of Frankforce. According to Franklyn, this would complete one of the two tasks that the Commander-in-Chief had given him, this being the securing of the town of Arras. His other task was of course to block the roads leading south from Arras, and for this he would have to await the arrival of the 1st Army Tank Brigade and the 151st Infantry Brigade. Franklyn recalled in his own account of Frankforce that:

> The 151st Infantry Brigade and the 1st Army Tank Brigade (only two battalions) were not due to arrive in the area until very late that night, the latter after a long march.
>
> The 17th Infantry Brigade would not arrive till early on the 21st. Any operations before 1100 hrs on the 21st were, therefore, impossible.

The role of the 17th Infantry Brigade (of 5th Division) was to occupy Vimy Ridge after the 151st Brigade had moved forwards, thereby ensuring this feature remained secure. It should be recalled that 4 RTR had undertaken a divisional exercise with the 17th Brigade at the end of March, the results of which had been the subject of both a talk and report by Harold Franklyn. It is therefore of note that the operation at Arras had been entrusted to an infantry brigade, the 151st, that had no previous experience of working with tanks, instead of one that did (the 17th) despite it being in the same vicinity. The 1st Army Tank Brigade's account asserted that Douglas Pratt had arrived at Vimy and met 'Q' Martel prior to the arrival of Harold Franklyn, with Martel already scheming for the brigade to attack at dawn in concert with the 151st Brigade, although "No plans were sufficiently advanced to allow sufficient recce. this day." This would have been because Martel would not have been able to draw up any detailed plan without the input of Franklyn. Both 4 RTR and 7 RTR had moved off to Vimy in the middle of the afternoon, through roads whose tide of refugees once again made movement slow and difficult, with their wheeled vehicles arriving at Vimy in the evening and the tanks beginning to arrive during the night. 4 RTR were met by Bernard Cracroft, who put them in the picture regarding the enemy's movements near Arras, the regiment then bivouacing in the appropriately named Bois de la Folie, while 7 RTR's late arrival meant that they had to spend the night in the open.

The 20th May was a momentous day for the German Heeresgruppe A. Despite the abortive attack by 7. Panzer-Division on Arras, which had been led by its commander, *Generalmajor* Erwin Rommel, other panzer divisions had been more successful. 8. Panzer-Division had not only reached its objective at Hesdin, 23 miles (37 km) northeast of Abbeville, but had pushed on to Montreuil, a mere seven miles (11 km) from Le Touquet on the Channel coast. In doing so it had engaged the unprepared territorial 70th Brigade (of the 23rd Division) in the open and largely destroyed it. 2. Panzer-Division had captured Abbeville itself from the British defenders, while 30 miles (50 km) further inland 1. Panzer-Division had seized Amiens, gaining a considerable southern bridgehead over the Somme from this town. 6. Panzer-Division had invested Doullens, midway between Arras and Abbeville, overcoming the outnumbered British infantry of the 36th Brigade (of 12th Division) after tenacious resistance, while its advance units had managed to reach Le Boisle, between Abbeville and Hesdin. This series of thrusts had captured a swathe of country north of the River Somme, and largely destroyed the 12th and 23rd Divisions. As a consequence, the whole tract of land between the Scarpe and the Somme rivers was in German hands and the British lines of communication were fully severed. The opportunity was also presented for the German panzers to pivot north up the coast to the Channel ports, and thus negate any opportunity for the British to evacuate. In response Lord Gort would attempt to reinforce his southern front along the Canal Line, this consisting of an unbroken series of canals and canalised rivers stretching from Gravelines on the coast to the southeast of Lens, it including a number of fortified towns such as Aire-sur-la-Lys, Saint-Venant, and Béthune. This was the only natural barrier that could hinder Heeresgruppe A from driving into the British rear, although initially Gort would once again have to rely on the deployment of improvised forces.

In the early hours of 21st May a conference was held at the GHQ Command Post at Wahagnies, this being attended by Lord Gort, Henry Pownall (CGS), Oliver Leese (DCGS) and Major-General Thomas Eastwood,

Abandoned Infantry Tank Mk. I from the second production batch, demonstrating how the front stowage bins hinged rearwards. The hawser is in the correct position on the nose of the vehicle, while the splash guard can be seen just above the driver's visor. This photograph gives a good view of the firing mechanism of the nearside 4-in (10 cm) smoke discharger, which was adapted from a 0.303-in. (7.7 mm) rifle. (Robert Gregory Collection)

the Vice-Chief of Staff (VCGS), where it was decided to proceed with the limited operation to relieve the pressure at Arras. As it was known that Harold Franklyn had a conference planned on this matter at 0600 hours, Oliver Leese was dispatched to attend, along with two of his staff officers. According to Douglas Pratt's personal notes, the last tanks of 7 RTR did not reach Vimy until 0700 hours, although Harold Franklyn had informed him that the "situation brooked no delay and that his orders from G.H.Q. insisted on attack at the earliest possible moment." Elsewhere the repairs being carried out by the 1st Army Tank Brigade Workshop were interrupted once again, as contrary to their expectations of remaining in place at Tressin, they were ordered to move 25 miles (40 km) southwest to the village of Vermelles. This journey was conducted on roads that were severely congested by the movement of other British units, whose vehicles became intermingled with their own, the unit eventually setting up shop in Mazingarbe, just south of Vermelles, in the early hours of 21st May. Prior to this the recovery section had already picked up and quickly repaired an Infantry Tank Mk. I from the woods near Vimy, and returned it to its unit, this most likely being 4 RTR in the Bois de la Folie. The two tanks from Tressin would also arrive for repair to continue, while the recovery section was posted eight miles (13 km) to the southeast at Le Petit Vimy, on the eastern edge of Vimy, in readiness for the upcoming operation.

Frankforce issued their Operation Order No. 1 at 0500 hours on the morning of 21st May, this beginning with a vague and incomplete precis of the movements of the Germans the previous day. It did however indicate that enemy tanks had been present on two of the roads running west from Arras, those to Saint-Pol-sur-Ternoise to the west and Doullens to the southwest. Strong columns of tanks and infantry had also been sighted the previous evening on the Arras road out of Cambrai, this indicating that the Germans were resuming their assault on Arras in force. The implications of these observations would however be ignored. The operation order then stated that before dawn the 150th Infantry Brigade of 50th Division, and the 13th Infantry Brigade of 5th Division, were to occupy the line of the Scarpe from Saint-Laurent-Blangy, just to the east of Arras, to Biache-Saint-Vaast seven miles (11 km) further east. This would therefore relieve the French cavalry, who could then move over to cover

the right flank as previously arranged with René Prioux, and also the British 69th Infantry Brigade (of the 23rd Division), who had been under French command. Anti-tank screens would be established behind this line on both flanks, while the two brigades would be supported by the artillery of their parent divisions. Lumsdenforce were given the role of reconnoitering a sector to the northwest of Arras, from the Saint-Pol road up to the Béthune road, their particular task being to "report presence and movement of enemy A.F.Vs." This would preclude them from providing reconnaissance for any offensive action to the south of Arras.

Harold Franklyn duly held his conference at the 5th Division's headquarters at Vimy at 0600 hours to devise the plan of attack, this being attended by Oliver Leese, Vyvyan Pope, 'Q' Martel and Douglas Pratt, who recorded his own attendance as commencing at 0800 hours. Not confirmed as being in attendance was Brigadier John Churchill, the commander of the 151st Infantry Brigade, despite the fact that his formation had established its headquarters at Vimy in the early hours of the morning, it not receiving a warning order for the attack until 0630 hours. It is also not clear whether any Royal Artillery personnel or representatives of the French cavalry corps were present. Nevertheless the general idea was that the combined 1st Army Tank Brigade and 151st Brigade were to form two columns that were to be assembled at forming up points in the villages of Marœuil and Anzin-Saint-Aubin, which were located four miles (6 km) to the northwest of Arras. This was to be accomplished by 1300 hours that afternoon, meaning that the tanks of 4 and 7 RTR would have to leave Vimy at 1100 hours in order to cover the seven mile (11 km) journey to the two villages, which were 2½ miles (4 km) apart. From the forming up points, the two columns would make the four mile (6 km) journey south to the start line, which they were expected to cross at 1400 hours, before attacking southeastwards around the south of Arras. The attack was to be covered on its outer (*i.e.* right) flank by an advance by 3e DLM, although no arrangements appear to have been made for them to send representatives to the forming up points. The 1st Army Tank Brigade's account suggested that the drafting of the plans had been less than methodical, as "only hurried plans were made, verbal orders being finally issued at 0900 hrs." After leaving the conference, Douglas Pratt visited the headquarters of the 50th Division in order to consult with 'Q' Martel on the liaison arrangements between his brigade and the 151st Infantry Brigade, the result being that:

> A request for joint recce by Tank Bn. and Inf. Bn. Comrs. prior to the attack or even a meeting was overruled by Comdr. 50 Div. who insisted that as time was short it was impossible to carry any of these essentials out until the forming up position at MARŒUIL – ANZIN had been reached.

One other person who appears to have been briefed at the 50th Division's headquarters was Lieutenant-Colonel Wood of the 4th Royal Northumberland Fusiliers, who were to provide a forward screen for the forthcoming attack. Douglas Pratt then returned to his own headquarters at Le Petit Vimy, where his Reconnaissance ('R') and Orders ('O') groups awaited him. The 151st Brigade held their brigade conference at 0945 hours, this being graced by the presence of 'Q' Martel, who explained the plan and the purpose of the attack. The 1st Army Tank Brigade were already holding their own conference on the plans, which did not finish until after 1000 hours, with the routes and objectives for the two tank battalions once again being issued verbally. Pratt recalled that:

> This had left little time for Coy. Comrs. to issue orders or even explain the plan to Sec. Comrs. There is no doubt that the whole operation was far too rushed and that even 2 hours would have allowed time for these essentials.

Nonetheless a set of written orders were issued in the form of the brigade's Operation Order No. 6. This stated that the Germans had light elements, including light tanks and armoured cars, around the southern outskirts of Arras, these possibly being accompanied by infantry, while their columns were moving towards Doullens, 22 miles (35 km) to the southwest of Arras. The 151st Brigade were to attack around the west of Arras and then to the south, with the support of the 1st Army Tank Brigade and the divisional artillery of the 50th Division. According to Operation Order No. 6, the attack was to proceed in three phases, the first being the accompaniment of the infantry of the 151st Brigade to the start line for the attack, which was the railway running southwest from Arras either side of the junction, south of Dainville, where the line to Boulogne and Calais branched off to the north. Dainville itself was a short distance west of Arras, the start line being nine miles (14 km) to the southwest of Vimy. The choice of this line was a curious one, as Frank Force Operation Order No. 1, which had been issued earlier at 0500 hours, had indicated that German forces were already operating north of this line, albeit further to the west. The tank battalions were to set off by crossing Vimy Ridge, just to the southwest of Vimy, at 1100 hours with the aim of meeting the infantry at their assembly areas at Marœuil and Anzin-Saint-Aubin, to the northwest of Arras, and escorting them to the start line in time for the commencement of the second phase. The second phase was to be the clearing of the area south of Arras by advancing southeastwards

from the start line to the River Cojeul, with the tanks crossing the start line at 1400 hours and the infantry marching behind them. The Cojeul was about five miles (8 km) south of Arras, the line of the river running to the northeast and being approximately six miles (10 km) from the start line. At the end of this phase, all the major roads running south from Arras would have been cut except the one to Cambrai. The third and final phase was the clearance of the area between the Cojeul and the River Sensée, a further two-and-a-half miles (4 km) to the southeast, the timing of this attack being dependent on the time taken to reach the Cojeul and thereby complete the second phase. During this last phase the 13th Infantry Brigade (of the 5th Division) were to undertake a simultaneous attack over the River Scarpe to cut the road running southeast from Arras to Cambrai where it intersected the Sensée. This would therefore ensure that Frankforce had completed the second of its major tasks, which was the blocking of all the roads south of Arras.

The line of advance for 4 RTR was to run southeast along the road from Dainville, taking the level crossing over the railway just outside the village of Achicourt, before capturing Achicourt itself. From here they were to continue southeast to the village of Beaurains, and then northeast to the hamlet of Tilloy-lès-Mofflaines, before switching southeast again for a longer run to their first objective of Wancourt, on the Cojeul. From here they would take the last bound southeast to the final objective of Chérisy on the Sensée. As the right column, led by 7 RTR, was in effect taking the outer route, the distance they were to travel would be greater, this starting at the level crossing on the road from the hamlet of Berneville to the village of Wailly. After seizing Wailly they were to make the 3½ mile (5.5 km) journey east and slightly south to Mercatel, before turning northeast to take Neuville-Vitasse, and then take a sharp turn to the southeast to the first objective of Hénin-sur-Cojeul. The final bound was once again southeast, to Croisilles on the Sensée, this being roughly three miles (5 km) southwest of 4 RTR at Chérisy. The two battalions of the 151st Brigade partaking in the advance were the 8th Battalion of the Durham Light Infantry (8 DLI) on the right (*i.e.* western) flank and the 6th Battalion (6 DLI) on the left (eastern) flank, with 8 DLI being supported by 7 RTR, and 6 DLI being supported by 4 RTR. 6 DLI had arrived at Thélus, south of Vimy, by mechanical transport at 0330 hours that morning and after breakfasting were standing by to move by 1030 hours, the distance to Anzin-Saint-Aubin being 4½ miles (7 km). Their vanguard 'D' company had marched on foot to Thélus the previous day and set up defensive positions. 8 DLI, also travelling by mechanical transport, had reached Vimy itself by 0400 hours, their company and specialist platoon commanders having been given an outline of the plan at 1030 hours, this allowing them to mark up their maps accordingly. It should be noted, however, that Operation Order No. 6 erroneously identified the infantry battalion allotted to the right flank as the 9th Battalion of the Durham Light Infantry, who were in fact to be in reserve. It is also noteworthy that this order did not define who would ultimately be in command of each column, *i.e.* whether it was to be the tank or the infantry battalion commander, and though the order stated that the tanks were to support the infantry, there was a degree of ambivalence over which arm was in fact to lead the assault. Indeed, 4 RTR's subsequent report on the operation indicated that they were under the impression that the infantry of 151st Brigade had been tasked with supporting them. In order to better distribute the heavier Infantry Tank Mk. II's, two sections of these (*i.e.* six tanks) from 7 RTR were to join 4 RTR.

The two battalions of the Durham Light Infantry were to each be supported by a battery of artillery from the 92nd Field Regiment of 5th Division, and a battery of anti-tank guns, these being from 65th Anti-Tank Regiment (of 50th Division) for the right hand column and 52nd Anti-Tank Regiment (of 5th Division) for the left. Forward observation officers (FOO's) for each field battery were to advance with their allotted infantry battalion, these being able to relay any potential targets identified by either column. The batteries themselves were equipped with 18 pounder and 18/25 pounder field guns, the latter being a hybrid in which the barrel and breech of the new 25 pounder were mounted on an 18 pounder carriage and jacket. Not mentioned in Operation Order No. 6 was that the two columns were to be screened by elements of the 4th Battalion of the Royal Northumberland Fusiliers (4 RNF). As such the latter's 'Y' Company was to accompany 6 DLI on the left, along with the Daimler Scout Cars of their No. 11 Scout Platoon, while 'Z' Company and the scout cars of No. 12 Scout Platoon were to move with 8 DLI on the right. Also not mentioned in the brigade order was the presence of 3^{e} DLM on the outermost flank, and it is uncertain to what extent, if any, either 4 RTR or 7 RTR were aware of the French role. A recovery post for the tanks was to be established at Le Petit Vimy at 1500 hours, the workshop recovery section already being at this location, while wireless silence was to be maintained until 1330 hours within the brigade, this meaning that each battalion would not be able to establish and test its own wireless net until half an hour before crossing the start line. Each regiment and the brigade headquarters were allotted different frequencies, while no details on the frequencies allotted to the headquarters or units of 151st Brigade or 50th Division were given. As this meant that no wireless communication with the infantry would be possible, brigade and battalion liaison officers were to be provided to the 50th Division's headquarters and to the two battalions

of the DLI. Indeed, 8 DLI would record that the liaison officer from 7 RTR joined them with his wireless car at around 1100 hours. Once the start line was crossed, the 1st Army Tank Brigade's headquarters was to move from Le Petit Vimy down to Dainville, in line with the headquarters of the 50th Division and 151st Brigade. Operation Order No. 6 was signed by Bernard Cracroft at 1120 hours for delivery to units by dispatch rider, and, according to 7 RTR, was never seen by either themselves or 4 RTR, or indeed by any other unit. One of the critical consequences of this omission was that neither battalion would know that before reaching the start line they would be able to cancel wireless silence, with the unit's Reconnaissance Officer, 2nd Lieutenant Peter Vaux, recollecting that:

> The 7th had a bit of a rush to lay it on. The 4th were not rushed at all because they [had] got to PETIT VIMY well before the 7th. The 4th were properly organised, tk crews were briefed and the only reason the sets were not netted was because Bde laid down a wrls silence in Belgium and it was never lifted! We could easily have netted in the time avail[able] and in fact some tks did do so regardless of orders.

It would also be the case that without having received the brigade operation order, they may not have known the correct frequency on which to broadcast, even if some tanks had netted. The difficulties being experienced by 7 RTR were alluded to by Major George Parkes, the commander of that battalion's 'D' Company, who recalled that:

> There was no time for detailed battalion orders and coy commanders had a very limited opportunity for [giving] orders to their companies. Maps were very few and tank commanders in several cases were acting quite blindly following their section leaders so far as they were able.

Both battalions had already moved off for the start line by 1100 hours, with 7 RTR stating that they had actually left their assembly area at 1000 hours to commence the approach march to this line. The battalion alleged that they had been promised air support, and added that "No time for reconnaissance, very few maps and lack of information contributed to difficulty of situation." The report by 4 RTR on the events at Arras was written by the regiment's adjutant, Captain Robert Cracroft, who was the younger brother of the Brigade Major, Bernard Cracroft. This corroborated the claim by 7 RTR that air support had been promised, and also stated that their Commanding Officer, Lieutenant-Colonel Fitzmaurice, issued the verbal orders for the attack at 1030 hours, these being given to his company commanders and to Major Hedderwick, who was in charge of the Infantry Tank Mk. II's. According to Cracroft, Fitzmaurice had ordered the battalion to proceed directly to the start line south of Dainville under the second-in-command, Major J.S. Fernie. In the meantime, Fitzmaurice, Cracroft, and Peter Vaux would proceed to Anzin-Saint-Aubin in their Light tanks to meet up with the infantry. Fitzmaurice had stipulated that from the start line the battalion were to attack "two up", with 'B' Company on the left, 'C' Company on the right, and 'A' Company in reserve, the A12's also being placed in reserve.

The 50th Division's Operation Order No. 9, the "master plan" for the attack, was issued at 1200 hours, although 1st Army Tank Brigade do not record having received it. This outlined that the attack was to advance west of Arras and then turn southeast to "destroy enemy forces in the area South of R.SCARPE as far east as R.SENSEE". It also confirmed that "French troops are cooperating west of ARRAS." Of the two advancing columns, it was confirmed that these would be under the command of the infantry battalion commanders, with the right (outer) column being designated "Red" and the left (inner) one designated "Blue". The start points were indicated as being at the road junctions just behind the railway crossings given in the 1st Army Tank Brigade's operation order, although the centre lines for the advance beyond the start line were identical. However, Operation Order No. 9 did set the right hand (Blue) column a route through the village of Warlus on the way to the start line. The divisional headquarters, like that of 1st Army Tank Brigade headquarters, was to follow the Red route and establish itself at Dainville, while the 151st Brigade headquarters were to move forward to Écurie. The first objective on the Cojeul was demarcated as being a line running northeast from the village of Boyelles to a bridge over the river just to the south of Guémappe, which was to the northeast of Wancourt. The second objective was a line on the Sensée between Croiselles and Vis-en-Artois, with Operation Order No. 9 mandating that "On capture of second objective infantry will immediately consolidate in tank proof localities", this implying fortification by means of barricades and roadblocks, and the siting of anti-tank guns. More specific information was given on the location of ammunition points, these to be successively established at Marœuil, Dainville and Achicourt, while the petrol points were to be sited at Marœuil and then Dainville, these presumably operating separately from the 1st Army Tank Brigade petrol point east of Givenchy.

The commander of 3e DLM, *général de division* Jean Langlois, issued his *Ordre D'Operations* (No. 6/3 Op.) at 1250 hours, this stating that his formation, reinforced with the tanks of the independent *groupe de bataillons*

de chars 515 (GBC 515, Tank Battalion Group) was to cover a British attack from Arras in the direction of Cambrai. As such, they were to move through the villages of Gouves and Warlus to the line of the Arras to Doulens railway, from where they would commence their attack at 1400 hours alongside the British. Their line of advance would then be through Brétencourt and Hendecourt-lès-Ransart to Boiry-Sainte-Rictrude, their first objective being the line of the Cojeul from this town as far as Boiry-Becquerelle, 2½ miles (4 km) to the east, and including Boisleux-au-Mont. This would place them on the right flank of the 50th Division's first objectives on the Cojeul, which were of course from Hénin-sur-Cojeul to Wancourt. From here, the French would proceed to their second objective, which was a line from Moyenneville east through Hamelincourt to a crossroads at Maison Rouge, just to the northwest of Saint-Léger. This would in turn cover the right flank of the final British objective of the Sensée. The divisional *5e brigade légère mécanique* (5th Light Mechanised Brigade), along with GBC 515, were to attack all fixed objectives, while being ready to face any German attack that might come from the south or west. The 5e brigade légère mécanique comprised two cavalry battalions, these being the *1re* and *2e régiments de cuirassiers* (1st and 2nd Cuirassier Regiments) which were each nominally equipped with 21 Somua S35 and 21 Hotchkiss H39 tanks, although heavy casualties in Belgium had considerably reduced their strength. The motorised infantry of the *11e régiment de dragons portés* (11e RDP, 11th Motorised Dragoon Regiment) would not however accompany the main attack, but would hold the villages of Beaumetz-lès-Loges and Brétencourt, which straddled the start line, and cover the rear of 5e brigade légère mécanique. They would have with them a battery from *1re groupe de artillerie* (1st Artillery Group), who would assist the brigade in achieving its objectives, while also providing anti-tank defence. As such the seizing of the two main objectives would be assisted by artillery but not by motorised infantry. In addition a section of 47 mm anti-tank guns and a machine gun battalion would be dispatched to Duisans in the rear to provide defence against any attempted enemy encirclement of Arras, while the divisional reconnaissance regiment (12e régiment de cuirassiers) was to reconnoitre towards Doullens to the west, Bapaume to the south, and Puisieux between the two.

50th Division's Operation Order No. 9 was received by the 151st Infantry Brigade at 1300 hours, encouraging them to draft their Operation Order No. 10 which was recorded as being completed only ten minutes later at 1310 hours. The order began by stating that "Enemy infantry and tanks are known to be operating in the area South and S.W. of ARRAS in numbers which are uncertain but not believed to great", although this latter belief was soon to be disabused. It was then imparted that "A counter attack is being launched to-day with the object of checking the hitherto uncontrolled activities of small enemy units in this area". Unlike the orders issued by Pratt and Cracroft, Operation Order No. 10 did at least hint at the presence of 3e DLM, by mentioning that "The counter attack is being carried out by French tanks on the right, 151 Inf Bde in the centre and 17 Inf Bde in the second phase on the left." It also confirmed that the first major objective was to be the line of the River Cojeul and the second the line of the Sensée, although the lines to be occupied were not in the same vicinity as had been delineated in 50th Division's order. Instead the line on the Cojeul to be seized was stated as being between the villages of Boisleux-au-Mont and Hénin-sur-Cojeul, and the line on the Sensée between Saint-Léger and Croisilles. These objectives were on a narrow front between the 50th Division and 3e DLM, with a slight overlap on the left flank of the latter. This implied that 151st Brigade were expecting to advance on a much straighter and more southerly line than 1st Army Tank Brigade.

The minimum distance from the forming up points to the final objective on the Sensée would be twelve miles (19 km), this of course having to be covered on foot. As well as 6 DLI being on the left flank and 8 DLI on the right, 9 DLI were to provide the reserve for 8 DLI on the right. With regard to the liaison with 1st Army Tank Brigade, Operation Order No. 10 simply stated that "I Tanks will lead, Mk. II med tanks in support", and that "Fwd bns follow on each route with one coy I Tanks in close support." This indicated that the infantry would follow the leading wave of Infantry Tank Mk. I's, while being accompanied by a reserve company of Infantry Tank Mk. I's, the Infantry Tank Mk. II's playing a supporting role in case of strong resistance. Once the objectives were seized, the infantry were to mop up between the brigade boundaries, which included Berneville, Wailly, Boisleux-au-Mont and Saint-Léger on the right, and the Arras to Vis-en-Artois road on the left. This road was far to the east of Croisilles, and was in the area to be gained by the 1st Army Tank Brigade, indicating an anomaly between the boundaries specified by the orders and the objectives stated. There were also no instructions to establish tank proof localities, as had been stipulated by the divisional orders. The major significance of Operation Order No. 10 was in its divergence from the orders given by the 50th Division, possibly due to the speed of its transcription, it also being considerably more vague than those issued by 1st Army Tank Brigade or 3e DLM. Another complicating factor unknown to the senior commanders of Frankforce was that *Generalmajor* Rommel was intending to resume the advance of 7. Panzer-Division at 1400 hours that day, his plan being to manoeuvre his formation, which was to be flanked on the right by the *SS-Totenkopf-Division*, around the

Glenlyon, *a second production batch machine assigned to 'D' Company, 7 RTR. This picture gives a good view of the nearside outlet ventilation louvre and underlying roof plate hinged back on the central roof plate. Gas detection paint is visible on the glacis plate and on the turret roof, while the underside padding has been removed from the quadrant door of the turret hatch, this being a common sight on abandoned tanks of 1st Army Tank Brigade.* (Private Collection)

west of Arras in order to seize the high ground to the north of the town. This would also necessitate seizing crossings over the Scarpe, and put his force on an almost direct collision course with Frankforce's attack, the purpose of the German attack being to secure the northern flank of Heeresgruppe A's invasion corridor.

Lieutenant-Colonel Fitzmaurice, Robert Cracroft and Peter Vaux motored ahead of the main body of 4 RTR in their fast Light tanks to Anzin-Saint-Aubin, where they met up with 'Q' Martel and Douglas Pratt. Cracroft claimed that "No trace of the infantry could be found and information was finally received that the infantry would be an hour late in crossing the start line." The absence of 6 DLI would not however be allowed to delay the attack, as "Verbal orders were also issued by the Brigadier at the same time that there would be no alteration in the timing of the Bde advance." The diary of 6 DLI suggested that they passed through Anzin-Saint-Aubin before 1230 hours and carried on marching to the hamlet of Louez which was midway between, and to the south of, Marœuil and Anzin-Saint-Aubin. At Louez their 'D' Company, which comprised their vanguard, had turned south to cross the River Scarpe, and at 1325 hours there was a halt for twenty minutes while the battalion's weapons were removed from their transport and orders were given. The main body of 4 RTR under Major Fernie had moved from Vimy without passing through Anzin-Saint-Aubin and without halting, the start line having been reached by 1345 hours. This endeavour had not been uneventful, as on reaching the crossroads at Dainville, just ahead of the start line, a request had been received from a French bicycle detachment in the village to deal with a German motorised column that was approaching from the west, this in fact belonging to *Schützen-Regiment 6* (6th Rifle Regiment). A section of tanks from 'C' Company under Captain D.W. Hunt was thus allotted to this task, with Robert Cracroft relating that "He disposed his Section to the WEST of DAINVILLE, killed many of the enemy and destroyed their vehicles and thus broke up their advance." On reaching the railway beyond the village, Cracroft recorded that "The Bn formed up according to plan and as previously arranged advanced over the start line at 1400 hrs without further orders from the C.O." A similar series of events had unfolded on the right flank although the commander of 8 DLI, Lieutenant-Colonel Charles Beart, had motored ahead of his battalion to the forming up point at Marœuil with

Captain Dixon of the vanguard 'A' Company. In doing so, he managed to contact both 'Q' Martel and Hector Heyland at 1245 hours, with 8 DLI's diary chronicling that "O.C. Tank Battalion stated his tanks would be following line of road MARŒUIL – DUISANS – WARLUS to START LINE (Rd. ARRAS – DOULLENS)." However by the time the main body of 7 RTR managed to reach Marœuil the infantry had still yet to arrive, and so they decided to press on to the start line. Unfortunately in their urgency, and in the general sense of confusion, the tanks took a different route to one advised by Lieutenant-Colonel Heyland, electing instead to travel through Dainville and then west along the route nationale 25 (RN 25) to their starting point opposite Wailly.

Frankforce had issued their Operation Order No. 2 at 1345 hours, this plainly being too late to influence anyone in a position to affect events, although it did delineate Harold Franklyn's intentions for the operation. The order started by explaining that enemy transport had been spotted on the road from Arras to Saint-Pol at 1020 hours that morning, which would have been useful information to the infantry and tanks that were about to cross that very road on commencing their journey to the start line. It also stated that the intention of the attack was for Frankforce to clear and occupy a segment of territory to the southeast of Arras along the line of the River Sensée from Saint-Léger northeast to the stream known as Le Trinquise, which flowed northwest into the Scarpe near Biache-Saint-Vaast. The method of achieving this was stated as being that in its initial phase, the combined 1st Army Tank Brigade was to clear and capture the area of south of the Scarpe, including the southern outskirts of Arras, and then the villages of Monchy and Pelves, near the south bank of the Scarpe and to the east of Arras. They would then move a short distance south to the River Cojeul, and clear it in a westerly direction up to the road from Arras to Bapaume. These were obviously quite different instructions to those given by 50th Division and its sub-formations. After this was accomplished, on 'Q' Martel's orders the two brigades were to clear the areas between the Cojeul and the Sensée from the railway line at Saint-Léger in the west to the road from Arras to Cambrai in the east. In concert with this second phase, the 13th Infantry Brigade would cross the Scarpe and occupy the rest of the intended segment to the north of the Cambrai road, this constituting the third phase. Once captured, the areas occupied by the 151st Brigade and the 13th Brigade would be organised into a series of anti-tank obstacles, while the 1st Army Tank Brigade would adopt a defensive posture to provide protection against armoured fighting vehicles moving in from the west. It was even rather fancifully suggested that if the situation was favourable then Bapaume, fourteen miles (23 km) south of Arras, might be reoccupied. Concerning the actions of the French, it was set forth that:

> (a) 1 D.L.M. is co-operating in the above, by attacking on the right of Major Gen. MARTEL's force.
>
> (b) 2 D.L.M. is to co-operate on the left flank of 13 Inf Bde ...

In fact it was of course 3e DLM that was operating on the flank of the British attack. Regarding fire support, Operation Order No. 2 would state that:

> Div Arty of 5 and 50 Divs will support the adv in all three phases, by observation. C.R.A. 50 Div will co-ordinate.

This suggested that artillery support would not only be provided by the batteries of the 92nd Field Regiment, but also by the other four field regiments that were integral to the two divisions, these being the 91st and 97th of the 5th Division and the 72nd and 74th of the 50th Division. The statement that these units were to fire by observation indicated that they were to employ forward observers to identify potential targets, without necessarily liaising with the attacking force. However, any support from these units would be on the presumption that the tanks and infantry would be moving in much closer proximity to the Scarpe than they had in fact been instructed to. The Commander Royal Artillery (CRA) of 50th Division, Colonel R.M. Graham, had attended a divisional conference held by 'Q' Martel at 1045 hours, one of a seemingly inordinate number of meetings that had been held that morning. The purpose of the get together had, according to Graham, been to "prepare a plan for future action", this presumably to be undertaken after the current attack south of Arras had been completed. The decision taken at this conference had been that the 50th Division would be divided into two Brigade Groups, with each group being supported by a single field battery and a single battalion of tanks. The groups, which were presumably to be based around the 150th and 151st brigades, were to be self-contained and have the purpose of "seeking out & engaging the numerous mechanised detachments of the enemy forces." To this end Graham and his intelligence officer, 2nd Lieutenant Hammond, were to accompany the attack from around 1500 hours, this of course meaning that he would not be coordinating the artillery programme as Harold Franklyn expected. Regarding air cover for the operation, Operation Order No. 2 set down that the RAF was to be engaged in:

> (a) Providing fighter protection over concentration area astride rd ARRAS – VIMY, particularly over area VIMY.
>
> (b) Providing intensive fighter protection between 1100 – 1600 hrs to cover approach march of 1 A. Tank Bde and initial phase of operations.

(c) G.H.Q. is arranging air bombing action against any specially favourable targets."

By this time the RAF were completing the evacuation of their squadrons from the area north of the Somme, with the Air Component at GHQ about to become the Back Component, which would attempt to coordinate air cover from England. The results of this interregnum, in addition to earlier grievous losses, were already apparent with no British aircraft so far having been sighted over the operational area, and German aircraft apparently having free rein. Finally, regarding Lumsdenforce, the order set down that:

After completion of tasks laid down in FRANK FORCE O.O. No. 1, will carry out recces on right flank of adv of Major Gen. MARTEL's force. Recces to extend Southwards towards BAPAUME.

This would obviously be too late to be of any use in the current operation, with the tanks of 4 and 7 RTR, and the Durham Light Infantry having to advance into the unknown. Warrant Officer Class III (WO III) William Armit, who was in charge of the right hand section of 4 RTR's 'C' Company, gave an account of the difficulties that would immediately be encountered, as:

My tank like those of all Section Commanders was a Mk. I armed with a ·5 Vickers machine gun. The other two tanks in my troop had ·303 Vickers ... I had to command the tank as well as operate the wireless and load and fire the gun which was a dreadful weapon to handle. We had an easy run down to the start line, but I had had no time in which to put my other commanders into the picture, there was only one map between the three of us, so the only plan was to lead with my own tank. I gave orders that the others should maintain a distance of 75 yards [~70 m] from me on either side.

Using the short range No. 11 Wireless Set was rendered particularly difficult in the Infantry Tank Mk. I due to its awkward position on the offside hull floor behind the commander. The incomplete, or in many cases absent, wireless netting would mean that most tanks would fight section actions with little understanding of their relationship to the battle as a whole, this necessarily generating highly impressionistic accounts of the day's events. The sense of blindness was enhanced by the fact that 4 RTR's "rear link" wireless set, which was tuned to the brigade headquarters frequency, had shorted before the start line had been crossed, this having been fitted in Robert Cracroft's tank. The unexpectedly strong presence of the Germans ahead of the start line apparently prompted Martel to switch the location of his forward headquarters to Écurie, to the north of Arras, rather than to the more vulnerable Dainville, with Pratt ordering his headquarters to be diverted likewise. Having crossed the start line, 4 RTR immediately encountered shellfire, which appeared to William Armit to be unobserved, this encouraging him to press on and engage several German troop-carrying lorries moving beyond the railway line, with apparently lethal effect. Robert Cracroft would relate that the nature of the ground in this vicinity, which included railway cuttings, forced 4 RTR to advance further to the right than its stipulated centreline indicated, at least until the first water barrier of the River Crinchon was crossed. This river, which was just over a mile (1.5 km) to the southeast of the start line, flowed into Arras through the villages of Achicourt and Agny, which were both just to the southwest of Arras.

By the time the infantry of 8 DLI had reached Marœuil it was coming under light shell fire, with the sounds of artillery and rifle fire indicating that the southern exits from the village might be held or covered by the Germans. A brief reconnaissance prompted the battalion to assign their move to the start line in four bounds, the first being to the main road running from Arras to Saint-Pol, the second being to Duisans, the third a comparatively long bound to Warlus, and the last another short bound to Berneville. From here they could move southeast to the railway crossing and on to Wailly. 8 DLI appear to have believed, or had been given the impression, that the tanks of 7 RTR were "very late" when in fact they had already departed, their liaison officer from 7 RTR being unable to get in touch with them. Shortly after leaving Marœuil some of the tanks of 7 RTR had come across German transport and infantry moving west along the main road before Duisans. They had therefore deployed astride the road and engaged them successfully, with the advance guard (*i.e.* 'A' Company) of 8 DLI witnessing several German vehicles in flames at 1400 hours and stating that two of the British tanks appeared to have been put out of action. The advance guard of 8 DLI were then asked by the commander of a tank company for the route that had been allocated to 6 DLI, this suggesting that the individual concerned was Major Hedderwick, whose Infantry Tank Mk. II's had been allocated to 4 RTR. Hedderwick, if it was he, was then seen to proceed southeast, with the advance guard of 8 DLI entering Duisans at 1430 hours, these witnessing the last tanks of 7 RTR advancing into the distance.

Ten minutes later the advance guard were joined by Lieutenant-Colonel Beart's group in Duisans, with a message being sent back to their 'B' Company to move forwards and clear the wooded area near this village. A section of three French tanks was encountered at 1450 hours. their commander expressing concern

A map produced by 7. Panzer-Division, giving their appreciation of the attack by 1st Army Tank Brigade and 3e DLM, the movements of their tanks being marked by the thick lines (originally in red), the corresponding German movements shown with thin black lines. This clearly shows the incursions led by Captain Robert Cracroft on the road west of Mercatel (1620 hours) and Major John King between Wailly and Ficheux (1630 hours). *(Location names added by the author.)*

as to their right (*i.e.* western) flank, as he believed that there were German tanks in strength in this area. A request was then sent by the liaison officer from the 65th Anti-Tank Regiment to their battery at Marœuil to come forwards and cover this flank. 8 DLI's diary did however note that the battery commander that had been assigned to them from the 92nd Field Regiment was not in touch with his own battery, this denuding them of artillery support. By 1500 hours the advance guard of 8 DLI were pushing on to Warlus, although they acknowledged seeing tanks moving on their right flank, about a mile (1.5 km) to the west, and signs of enemy troops digging in. If these tanks had been heading northwards, they would have been the forward elements of Panzer-Regiment 25 of 7. Panzer-Division, who were bypassing Warlus in order to reach Agnez-lès-Duisans, just west of Duisans, and the sighting prompted 8 DLI to request anti-tank cover in order to complete this bound.

Meanwhile on the left flank, the vanguard 'D' company of 6 DLI had passed through Wagnonlieu, midway between Louez and Dainville, at 1430 hours, at which point they encountered shellfire. The three forward companies ('B', 'C' and 'D') therefore dispersed into "artillery" formation before continuing the advance. The main body of 7 RTR also advanced through Wagnonlieu and Dainville, where they encountered troops from 6 DLI, with 2nd Lieutenant Craig of 'D' Company remembering that:

> Before crossing the railway we came across isolated groups of our own infantry — DLI and not the ones we were supposed to work with — and also saw and had a half-hearted battle with what turned out to be French tanks sitting in the open on the high ground 1000 yards [~ 1 km] WEST of ACHICOURT. Once the mistake was realized we moved on into the village and met up with some of the 4th, B Sqn of the 7th and Scout Cars of the GHQ Recce Unit ... They had knocked out a German A Tk Gun, and taken a few PW on the Southern outskirts on the road to Vailly.

Rear view of Glenlyon *whose name has been painted on the hot air deflector shield. Visible through the open transmission compartment hatch is the power take-off for the winch drive of the mine plough, which is covered with a protective cap. Note the empty jacking block stowage box, and the clamps for the missing exhaust silencer. It was the convention for tanks of 4 RTR to be given names starting with the fourth letter of the alphabet ('D'), and tanks of 7 RTR to be given names beginning with the seventh ('G').* *(Robert Gregory Collection)*

The "GHQ Recce Unit" referred to here was the 4th Royal Northumberland Fusiliers, the scout cars belonging to their No. 11 Scout Platoon, who along with 'Y' Company had managed to arrive at the start line in time to make an early liaison with 4 RTR. This had meant that there were at least some infantry accompanying the armour at an early stage, although the French tanks encountered would have wandered some distance east of their line of advance. 7 RTR's headquarters and 'A' Company were on the battalion left, and it appears to have been the latter who were in fact in Achicourt, while 'B' Company, perhaps realising where they should have been, would take the road southwest from Dainville towards Wailly. 'A' Squadron would in turn change direction southwards towards the proper line of advance, although it is not clear if it had been encouraged to do so by Hector Heyland, with 'D' Company coming forward from reserve. Wailly had already been approached by the recce Light Tank Mk. VI B of 2nd Lieutenant Tom Hepple of 'B' Squadron, who had engaged small parties of enemy in the vicinity before retreating, although he was unable to report his findings due to bullet damage to his aerial.

Although 4 RTR had started to get back onto its correct centreline after passing over the Crinchon, the leading 'B' and 'C' companies had started to become separated, so Lieutenant-Colonel Fitzmaurice had ordered the reserve 'A' Company forward to plug the gap between them. The tanks of 4 RTR then pressed on to the southeast toward the route nationale 37 that ran south from Arras along the western edge of Beaurains to Bapaume, as part of their advance to the first objective of Wancourt. It was in this area that the tanks and infantry became heavily engaged by the 105 mm guns of three batteries of *Artillerie-Regiment 78* (78th Artillery Regiment) of 7. Panzer-Division, which were concentrated southwest of Tilloy, another battery being positioned just outside Neuville-Vitasse. These had been deployed with the intention of supporting the continued advance of 7. Panzer-Division, although they would now be used in the anti-tank role against 4 RTR. Their presence was fortunate for Rommel, because there was nothing between these guns and the advancing light elements of 5. Panzer-Division to the east. They also dramatically influenced events by obtaining a lethal direct hit on the Light Tank Mk. VI B of Lieutenant-Colonel Fitzmaurice, the commanding officer of 4 RTR. According to Robert Cracroft, Fitzmaurice had been killed a couple of hundred yards south of the Rue Angèle Richard, which ran southwest from Beaurains, this placing him far to the right (*i.e.* south) of his battalion's centreline. Cracroft's driver, Trooper John Howell, recollected that Fitzmaurice's tank had been fifty yards (~50 m) ahead and to the right of their own, when it suddenly stopped dead. This prompted them to go over and investigate, although they received no response from the crew when they called over to them.

The Infantry Tank Mk. I of William Armit was also in action in this vicinity, his section having of course been allocated the outer right flank of the battalion. While moving forward from Agny, just south of Achicourt, towards Beaurains, Armit was intercepted by the second-in-command, Major Fernie, who informed him of Fitzmaurice's fate and tasked him with dealing with the battery responsible. According to his own testimony, Armit led the other two tanks of his section to this new objective, but while moving towards Mercatel they hit a sunken road known as Le Chemin de Mercatel, which only Armit's driver managed to negotiate, the other two A11's becoming stuck in the lane. Armit then met up with his company commander, Major Archie Holford-Walker, and requested his support, although the company was by now so scattered that Holford-Walker offered to assist directly. On resuming his advance Armit recalled that:

> Almost at once I ran smack into six anti-tank guns. They were not camouflaged and their only cover was a fold in the ground. I got two of them before they realised I was on them — the range was about 200 yards [~200 m]. The survivors started on me now and one hit the gun housing. This caused the recoil slot pin to snap and shook the gun back into the turret, jamming me between the shoulder piece and the back of the turret and, incidentally, causing a cross feed in the gun.

These guns would have been light 3.7 cm Pak guns, which were no match for the armour of the Infantry tanks, their potential owners being either Schützen-Regiment 6, *SS-Totenkopf*-Division, or *Panzerjäger-Abteilung 42* (42nd Anti-Tank Battalion). The "recoil slot pin" mentioned here was the side pin that secured the gun within its slide mounting in the tank. Armit further related that:

> I forced the gun back and pressed the triggers of my two smoke mortars, but they did not fire. Afterwards I found they had been shot off. During the next minute they hit my tank ten times but did no real damage. Gradually they started to pick their shots and one shot carried away a spoke of the track adjusting wheel. I decided to get back into cover to repair the gun and ordered my driver to reverse by zig-zags for a hundred yards [~100 m].

The smoke mortars were 4-in. (10 cm) ejectors, positioned either side of the turret, that were fired via a Bowden cable, each mortar discharging a smoke bomb (or "generator") of the "base ejector" type that distributed smoke from its base as it flew through the air.

The discharger consisted of the trigger and firing mechanism of a 0.303-in. (7.7 mm) rifle, with the barrel replaced by a cup for the smoke bomb, and the butt cut away. The Bowden cable was tapped through the trigger, the cable itself being actuated by a repurposed motorcycle brake lever inside the turret, with a blank cartridge (Rifle Grenade 0.303-in. cordite) inserted into the firing chamber providing the propellant for launching the smoke bomb up to 125 yards (115 m). The bombs could also be manually actuated, as:

> I had four spare smoke generators in the tank so the best plan seemed to be to light one and throw it out. I lit the generator and then found that my turret flap was jammed. It was quite a shock to have a smoke generator burning in the tank with the flap jammed but after a few seconds struggle I managed to get the flap open and chucked it and another out in front. It seemed hours before we got back into cover but in fact it can only have been a few minutes.

This cover was presumably the sunken road from which the tank had emerged, with the requisite repairs being effected, as:

> I got my gun going again and returned to the attack. They must have thought I was finished for I caught the guns limbering up — and revenge was sweet! Then I had some anxious moments with the track adjusting wheel before I persuaded it to behave with the assistance of my special tool — the sledge hammer.

William Armit then recounted that he made contact with a pair of Infantry Tank Mk. I's and a single Mk. II, although he did not identify their provenance. These rallied to the rear under a railway bridge to the south of Agny, although the conference between the crew commanders was soon interrupted, as:

> At this moment some enemy tanks and infantry attacked down the road. My gun was pointing in the other direction, but I don't think I have ever moved a turret so fast in my life. The leading enemy, luckily, were pointing in the opposite direction too. A belt of ·5 stopped him and flames started to come out of him, his gun stopped firing and the crew scuttled out. The second tank was hit by the 2 pounder from the Matilda and brewed up, too. That killed the attack — the infantry melted away.

The reference here to a "Matilda" was to the Infantry Tank Mk. II, this being the name mistakenly given it by some crews, although it would later be adopted as the official nomenclature. Armit then spotted Lieutenant-Colonel Fitzmaurice's tank 700 yards (~700m) to the northeast, but on inspection he found that "the side had been blown in and the CO and his gunner were dead inside." He then returned to what he described as his "composite" section at the railway bridge, and continued in action against the German infantry. This was proving to be a chaotic undertaking, as "They were giving up all over the place and then escaping as you took your eyes off them; you couldn't shoot 'em in cold blood." Armit moreover recalled that "The situation was terribly confused with tanks of the 4th and 7th mixed up all over the place with the Germans." Towards Beaurains he could see a number of tanks belonging to 'A' Squadron of 4 RTR, although he later realized that these had all been knocked out. According to Robert Cracroft, the opposition from the field guns and anti-tank guns between Beaurains and Mercatel had held up the advance of the main body of 4 RTR along the RN 37, which intersected the eastern tip of Mercatel. Cracroft reckoned that most of the remnants of the battalion's three companies were arrayed in this vicinity, these consisting of ten tanks that were widely separated, although Armit's tanks would not have been among them, as these had been positioned further back at the railway line south of Agny. By 1530 hours 6 DLI were passing through Dainville and past Achicourt, their diary remarking that:

> Tanks had shaken enemy morale and destroyed much equipment and transport; but some enemy infantry remained in ACHICOURT and AGNY. All Companies engaged in mopping up. Large number of prisoners taken.

According to a map the unit drew of their advance, their three leading companies, 'B', 'C' and 'D', swept southeast of Achicourt towards Agny, while their reserve 'A' company went around the north side of Achicourt itself. At around this time, 'Q' Martel visited 6 DLI and ordered them to seize Beaurains, two miles (3 km) to the southeast of Achicourt, and to render it a "tank proof locality". While this was occurring, back at Duisans there had been confusion of a different kind, as one of the anti-tank guns of the 260th Battery of the 65th Anti-Tank Regiment had been engaged by a group of five French tanks of 3e DLM at 1545 hours. The crew of the gun had returned fire, with casualties having been sustained on both sides before the French realised their mistake. Also at around this time, the commander of the battery from 92nd Field Regiment reported that their guns were now belatedly approaching Marœuil. He was accordingly asked to get them in position as quickly as possible to support 8 DLI's advance guard, while the 65th Anti-Tank Regiment were requested to send a troop forwards for the same reason.

Three tanks abandoned in a sunken lane south of Arras, this possibly being the same lane referenced by William Armit on page 147. It would appear that it was easier for the Infantry Tank Mk. I to enter these steep banked lanes than to extricate themselves, which is possibly why the lead vehicle has shed its offside track. *(Private Collection)*

Warlus was then severely shelled for twenty minutes, with the advance guard believing that this had originated from the British artillery. At 1600 hours 'Q' Martel arrived in Duisans and was apprised of the local situation, while he in turn explained the situation on the other parts of the front. He urged the battalion to keep pushing on, this prompting 8 DLI to split their force into two. As such, 'B' and 'C' companies, and two troops from the anti-tank battery, would remain at Duisans under the second-in-command, Major Ross McLaren, while Lieutenant-Colonel Beart would take his group forward to join the advance Guard approaching Warlus. These would be accompanied by 'D' Company, the mortar platoon and a section of the carrier platoon. At 1630 hours what appeared to be enemy tanks were spotted approximately a mile (1.5 km) northwest of Warlus, these moving southwards, and so the commander of the anti-tank battery was petitioned to bring a troop down to assist.

According to Robert Cracroft, at around 1600 hours infantry were seen marching towards the road running south from Arras to Bapaume, which also went through the western edge Beaurains. This was the first time that 4 RTR had set eyes on the men of the 6 DLI. Cracroft averred that he moved rearwards in order to make contact with their commander, Lieutenant-Colonel Miller, informing him that there was no enemy opposition on the ridge in front of them, which was the edge of the high ground that ran east of Agny and northeast to Beaurains. Cracroft additionally noted that "The infantry were at this time taking numerous prisoners who were putting up no opposition." According to 6 DLI's map of their movements, their 'C' Company had split into two groups in order to occupy this ridge, along with two platoons of 'D' Company, while the third platoon of 'D' Company moved into Beaurains. Part of 'C' Company took up positions just south of Beaurains, while 'B' Company were directed to the southernmost position on the ridge, just to the southeast of Agny. After having contacted the infantry, Robert Cracroft advanced into what he termed a shallow valley, and what his driver Trooper Howell described as a sunken farm track, this being 1000 yards (1 km) northwest of Mercatel. Here he rejoined the remnants of 4 RTR. During this short move, Cracroft had spotted numerous stationary armoured cars, transport vehicles and anti-tank guns located on the road running west from Mercatel, with some of the anti-tank guns being in position.

According to his own report, he collected as many tanks as he could and led an attack on the road, with the result that "very considerable damage was inflicted on both personnel and material, no further casualties being sustained by the tanks." However, according to the testimony of his driver, Trooper Howell, Cracroft had become impatient at the time it was taking for the other tanks to congregate, and so had decided to attack alone, as:

> Out of the sunken lane we went and straight for the enemy guns. We stopped suddenly and our gunner shot and set fire to two limbers that were making off. I could see the crews leap off. We carried on as fast as we could when suddenly we were right in amongst the gun positions the enemy getting mown down as they tried to escape. We ran over the trails but I don't think we were heavy enough to do much damage.

Cracroft's Light Tank Mk. VI B then started to draw heavy fire, this damaging the belly plate of the tank, leading him to retreat to a hull down position, from which he continued engaging targets. 6 DLI's advance had continued over the railway line that ran south from Arras along the eastern side of Achicourt, having been ordered at 1630 hours to leaguer at Beaurains, although the open country they had to cross in order to reach it made them vulnerable to enemy HE and small arms fire. At 1715 hours the enemy positions on the Bapaume road south of Beaurains were captured by their 'C' and 'D' companies, while their 'B' Company cleared Agny. This latter company then took up positions over the railway line to the east of this village, the battalion's headquarters having already been established at Achicourt.

By this time 7 RTR were making an uncoordinated attack on the German gun line that stretched in an arc from Wailly in the west to Neuville-Vitasse to the east. Their depleted 'A' Company, in concert with some A12's of 'D' Company, advanced on a broad front to the line of Neuville to Mercatel, and towards their original first objective of Hénin-sur-Cojeul beyond. 'B' Company, who had by this time crossed the start line at the correct place, were attempting to move on the originally planned course from further east. However, not all the companies of 7 RTR were on the correct line, as Lieutenant-Colonel Heyland had ordered 'D' Company to exploit southwards through the gap between Wailly and Mercatel. Rommel had intended to accompany the divisional Panzer-Regiment 25 on its thrust northwards, although he had been forced to return to the rear to hurry up Schützen-Regiment 7, who were supposed to be accompanying the advance of Panzer-Regiment 25 alongside Schützen-Regiment 6. In the event, Rommel had caught up with the Schützen-Regiment 6 and was accompanying them east of Wailly when the British struck. Having witnessed the retreat of the men of the *SS-Totenkopf*-Division before the advance of 7 RTR, he had organised the field guns of the 2nd and 3rd batteries of Artillerie-Regiment 78 at Wailly to successfully stop the tanks, these being assisted by the heavy 88 mm guns of *I./Flak-Regiment 23* (1st Battalion, 23rd Anti-Aircraft Regiment) to the south. Some of the light anti-aircraft guns of *leichte Flak-Abteilung 86* (86th Light Anti-Aircraft Battalion) and the remaining anti-tank guns of *Panzerjäger-Abteilung 42* (42nd Anti-Tank Battalion) also assisted in this task. These additionally arrested the progress of the 7 RTR's 'B' Company in the area known as the Bac du Nord, midway between Berneville and Wailly.

During 7 RTR's attack, a section of two Infantry Tank Mk. I's under Staff Sergeant Major Sidney Perry had engaged a strong German anti-tank gun position, receiving many hits in return, these eventually disabling Perry's vehicle. He accordingly ordered his driver to abandon the tank, and remained to engage the enemy with his machine gun until that too was put out of action. On seeing that the other tank of his section had been knocked out, he ran over to it under heavy fire and retrieved the crew, endeavouring to get them away. The Infantry Tank Mk. I's of Sergeant Charles Bell and Corporal Ernest Miles had engaged an anti-tank battery that had knocked out the tank of their section commander. Bell's tank received sufficient damage to one of its suspension bogies that it partly threw its track, forcing him to withdraw under the cover of Miles' tank. Both men then set about repairing the track under fire with the assistance of their drivers, Troopers Thomas Walsh and James Webster, before returning to the scene to finally wipe out the anti-tank battery. The Infantry Tank Mk. I of Corporal Frederick Kitchen and Trooper Victor Parnell had covered the other two tanks of their particular section against heavy anti-tank fire after they had temporarily become casualties, thus allowing their section's attack to recommence. Major John King, who commanded a section of two Infantry Tank Mk. II's, reported that he had overrun a battery of 3.7-cm-Pak anti-tank guns, although the forward tool box on the front of his tank had been set on fire, pouring fumes into the inside of the vehicle. He accordingly averred that "this sort of experience was repeatedly caused by external stowage catching fire." King claimed to have subsequently knocked out four enemy tanks, two of which had caught fire, this being made possible because "Their shells did not penetrate our armour on the Matilda, whereas our 2 pounder went right through them." His tank then broke through a road block built up from farm carts, before its engines "conked", this likely being due to the driver stalling, although the brief pause allowed the Germans to immobilise the turret with a heavy shell.

After regaining power, King recorded that he and another A12, commanded by Sergeant Doyle, managed to neutralise another anti-tank battery, although on this occasion it was Doyle's toolbox that ignited, his turret also becoming jammed. Both tanks then successfully engaged what was identified as an 88 mm anti-aircraft gun, although this marked the end of their run, with King's tank fully catching fire, and Doyle's being knocked out by the artillery at Mercatel. The most notable victim of the engagement in this area was Lieutenant-Colonel Heyland, who was killed in his tank, this meaning that both battalion commanders had been slain during the battle.

2nd Lieutenant Craig of 'D' Company, commanding an Infantry Tank Mk. II, would subsequently claim to have reached Wailly, destroying an enemy armoured car on his way. On reaching the crossroads within the village he engaged enemy traffic that was moving northwards, although "When occupied with this we were engaged at short range by a 37 mm A Tk Gun, again with no effect, which had been pushed round the corner of a house by German infantry." After receiving a shower of enemy grenades, Craig decided to pull back, and was eventually ordered to withdraw to Achicourt by the battalion's reconnaissance officer, 2nd Lieutenant Farnell-Watson. The diary of the 7. Panzer-Division gave an account of the shocking effect that the attack of the two British tank battalions had had on the German forces, it explaining that:

> The bulk of the division is surprisingly attacked from the flank by strong enemy tank forces followed by infantry coming from the direction of Dainville south and south east of Arras. A heavy battle develops between 1530 hrs. and 1900 hrs. in the area of Achicourt – le Bac du Nord – Berneville Bretencourt – Ficheux – Mercatel – Tilloy against hundreds of enemy tanks and following infantry.

The same three infantry tanks as on page 149, although the lead vehicle has had its turret rotated in a different direction. The tank in the foreground is an early example from the second production batch, retaining the original design of visor, albeit provided with the splash protection guard which can be seen just above it. The stowage bins are also absent, indicating delayed supply of the later design, while a belt of 0.303-in. (7.7 mm) ammunition is strewn over the nose. The symbol for a command tank can be seen on the rear of the turret. (Robert Gregory Collection)

> 1./Schützen-Regiment 6 under Major von Paris and Panzerjäger-Abteilung 42 under Col. Mickl had to bear through this particularly heavy casualties. Our own anti-tank guns are not effective enough even at close range against the heavy British tanks. The enemy breaks through the newly formed defensive front. Our guns are destroyed by fire or overrun and the crews mostly annihilated."

The fact that the Germans thought they had been fighting hundreds of tanks underscores the alarm that the seeming impregnability of the infantry tanks had generated, this giving the impression of a much larger force than that extant. The commander of the division, Erwin Rommel, also documented the initial results of the incursion, as:

> The anti-tank guns which we quickly deployed showed themselves to be far too light to be effective against the heavily armoured British tanks and the majority of them were put out of action by gunfire, together with their crews and then overrun by the tanks. Many of the vehicles were burnt out. SS units close by also had to fall back to the south before the weight of the attack. In places they bolted.

Panzerjäger-Abteilung 42 agreed with this assessment, dolefully noting that "Our own Paks are not effective against British heavy tanks at close quarters".

Over on the right flank, the advance guard of 8 DLI were working their way through Warlus, with their 'D' company being assigned to investigate the woodland to the east. Half an hour later, Lieutenant-Colonel Beart's group also entered Warlus, while at 1800 hours the advance guard had reached the fourth bound at Berneville, this putting them about a mile and a half (2.5 km) away from the start line, which they should have crossed four hours earlier. Shortly afterwards Lieutenant-Colonel Beart's group was caught in the open as it moved from Warlus in an air attack that lasted about twenty minutes, this causing ten casualties and slightly wounding Beart himself. His party now included three French tanks, one of which was being towed, as well as scout cars, carriers and anti-tank guns, and about half of 'D' Company. Three of the supply lorries that were accompanying them were also put out of action. By 1800 hours 6 DLI's 'C' and 'D' companies had driven the Germans out of Beaurains itself, it being estimated that by this time their forward companies had sent back 400 prisoners. However Rommel had ordered Panzer-Regiment 25, which had reached almost as far north as Acq on the River Scarpe, to double back and hit the 1st Army Tank Brigade in the rear, their ultimate destination being Point 74, just to the south of Dainville. By 1830 hours defensive positions had been taken up at Beaurains, with 'D' Company on the left and 'C' Company on the right, the battalion headquarters and the reserve 'A' Company having moved forwards to the crossroads midway along the road from Achicourt to Beaurains. This period also coincided with the first of a series of severe raids on the Beaurains area by Stuka divebombers of *Sturzkampfgeschwader 2* (No. 2 Dive-Bomber Squadron). As the attack by the 151st Brigade around the south of Arras had not made the progress that had been expected, the advance of 13th Brigade over the Scarpe to the east of Arras was cancelled.

From Robert Cracroft's vantage point facing Mercatel he noticed that the infantry of 6 DLI appeared to have withdrawn from their immediate positions on the ridge before Agny, which was approximately 2000 yards (2 km) behind him. He therefore led his tanks back over this ridge, taking up a forward rally position immediately behind the infantry. William Armit had spotted Cracroft flying his rally flag and followed him to the ridge, this flag being a rectangle comprising red, white and blue horizontal bands. However the infantry were being subjected to heavy fire from the battery east of Mercatel, and as their company commander attributed this to the presence of 4 RTR's tanks, he petitioned Cracroft to withdraw them further to the rear. Cracroft duly retired his tanks to another rallying point 400 yards (~400 m) behind, and readied them to assist the infantry in the event of a German counter-attack. In his report Cracroft estimated that the time was now around 1930 hours. At about the same time Robert Cracroft received a message from the 1st Army Tank Brigade's headquarters that stated "Stand fast. Await further orders." He then went back another 300 yards (~300 m) with the second-in-command, Major Fernie, to 6 DLI's headquarters at the crossroads, where they met the second-in-command, Major Peter Jeffreys and their liaison officer with the battalion, Major C.I. Lee. The latter then undertook to return to the brigade headquarters at Écurie in order to obtain further orders. Lee's initiative did of course reveal that there was no wireless contact with the Brigade headquarters, this of course being because the rear link set had shorted before the battle had started.

Over at Warlus, an enemy tank attack was developing, this coming in from the west and from the south up the road from Berneville, with at least eighteen tanks being identified, these being from the main body of Panzer-Regiment 25. This was fended off by a platoon from the 151st Brigade's anti-tank company as well as one of the three French tanks. The troop of the 65th Anti-Tank Regiment that had been ordered down to Warlus by Lieutenant-Colonel Beart had been held back due to having had to engage with six enemy tanks south of Duisans, of which five had been knocked out in quick succession. However

Discovery *of 'C' Squadron, 4 RTR, being enjoyed by some off duty German soldiers. The 0.5-in. (12.7 mm) ammunition belts indicate that this was a section leader's tank, with all fifteen 0.5-in. conversions having been employed within the 4th Battalion. Draped over the offside idler wheel appears to be the red and yellow "out of action" flag.* (Private Collection)

the remaining tank had managed to neutralise the anti-tank gun concerned, along with most of its crew. Another enemy armoured attack had developed on the western outskirts of Duisans, although this was not pressed home. However an anti-tank gun in this area had to be towed out of action by an Infantry tank, after some of its crew had been wounded, while the enemy tanks worked their way around the north of the village. Panzer-Regiment 25 admitted to losing three Panzer IV's, six Czech-built Panzer 38 (t)'s, and three or four light tanks in these engagements, while claiming to have destroyed seven British heavy tanks and six anti-tank guns. By 2000 hours Warlus was fully under siege, the force there, consisting of the remnants of the 8 DLI's advance guard and commanding officer's group, fending off enemy tank incursions with mortars while their forward posts engaged infantry from Schützen-Regiment 6 who were working their way forwards from the south.

The shelling of Beaurains was increasing by this time, and a quarter of an hour later, the elements of 6 DLI's 'C' and 'D' companies in the village were reporting enemy AFV's moving around their left (*i.e.* northern) flank, and machine gun teams and cyclists were working around their right flank, between themselves and the elements of 'B' and 'C' companies on the ridge east of Agny. They had also identified enemy artillery observers approximately 600 yards (~600 m) east of Beaurains. At 2030 hours it was decided to order a general withdrawal to Achicourt, with the reserve 'A' Company taking up a covering position on the railway east of Achicourt. According to Robert Cracroft, this period coincided with another heavy bombing raid, which also prompted the remaining infantry to withdraw from the ridge. By 2100 hours 'C' and 'D' companies had withdrawn to the crossroads between Achicourt and Beaurains where the battalion headquarters was located, with the remaining tanks of 4 RTR having been further withdrawn 200 yards (~200 m) behind them. Cracroft noted that it was starting to get dark, and as soon as his tanks were in position he returned to the crossroads where he found Major Fernie sharing the Light Tank Mk. VI B of the battalion's Reconnaissance Officer, 2nd Lieutenant Vaux. Cracroft erroneously believed that 6 DLI were in the process of being relieved, and asked Fernie to contact the "new" infantry commander. Fernie accordingly walked over to the 6 DLI's headquarters, where he spoke to Major Jeffreys, although while he was engaged in this conversation, tanks were heard

approaching along the road from Beaurains. Cracroft related that:

> As it had been previously reported that a Mk. II Tank had broken down on the ridge it was thought that it was this tank returning. At the request of the Infantry Comdr, the Adjutant [*i.e.* Cracroft himself] went to investigate. It was by this time quite dark and there was a considerable amount of smoke from fires burning in the vicinity. The leading tank had approached almost up to the cross-roads.

According to Peter Vaux, they were waiting in Achicourt for a dispatch rider from the brigade headquarters to give them further orders, although unbeknown to them this messenger had already been captured. It was a full moon that night, and Cracroft stopped the approaching tank by waving a bundle of maps in front of the driver's visor. Cracroft further recounted that:

> Flaps were then opened and German heads appeared; there was some shouting in German. It was then realised that it was a German tank about the same size or bigger than a Mk. II. The Adjutant shouted a warning and ran back to his tank a distance of about 250 yards [~250 m]. The German tanks started firing and took up a line along the road facing the Bn. rally position about 250 yards [~250 m] away.

It was apparent that there was more than one German tank present, with the British tanks firing in return, although the fight was tempered after a few minutes by Cracroft firing a smoke generator from his tank, the Germans eventually withdrawing. During the short battle Fernie had attempted to flank around the Germans in his adopted tank, this initiative leading to his disappearance and subsequent registration as missing. 6 DLI's diary indicated that before the German tanks had been beaten off by those of 4 RTR, their incursion had inflicted very heavy casualties on the men of battalion who were still in the open. According to a subsequent account by 4 RNF, their 'Y' Company and No. 11 Scout Platoon also suffered very heavy casualties from the tanks in attempting to cover 6 DLI's withdrawal. The German tanks were most likely from 5. Panzer-Division, who were on the right flank of 7. Panzer-Division. As there was no further trace of the infantry Cracroft decided to withdraw the remnants of 4 RTR to the brigade headquarters, moving through Achicourt and then striking north across country from the road between Arras and Dainville. William Armit remembered that:

> None of our tanks had a belt of ammo left so Capt Cracroft ordered us back to HQ. This was a tricky and nerve wracking business during which we were fired on by friend and foe and I had to sit by my driver and slap his face to keep him awake. Next day I inspected my tank and found that it had been hit 36 times. It was called DAUNTLESS and had lived up to its name.

6 DLI conducted their own withdrawal from Achicourt to Le Petit Vimy from 2200 hours onwards, this involving the battalion headquarters and the men of all four companies, as well as their 'A' echelon transport. It was however noted that 200 of them, including Lieutenant-Colonel Miller, lost their way and ended up at Boulogne, where they assisted in the defence of the town with the 2nd Battalion of the Welsh Guards, before being evacuated with the rest of the garrison to England. Small parties from 'C' and 'D' companies that had survived the final German tank attack also made their way back separately on foot. In the Duisans area the road to Warlus had been cut off by enemy tanks, although from 2200 hours onwards a few stragglers from Warlus managed to make their way back, including a party of officers who had travelled in Lieutenant-Colonel Beart's staff car. After darkness had fallen, Warlus had become subject to intense mortar fire which had set a number of houses on fire. A messenger was sent from Duisans to the headquarters of the 151st Brigade at 2300 hours in order to inform them of the current situation, this apparently having some efficacy, as around an hour later six French tanks and a pair of carriers arrived at Warlus to assist the evacuation of the survivors. In the early hours of the morning the force at Duisans withdrew to Marœuil, and at 0300 hours the retreat from Warlus commenced, the seventy survivors, including Lieutenant-Colonel Beart, being packed onto the remaining carriers and escorted by the French tanks, which were placed at the front and rear of the column. These would pass through Duisans at dawn and then on to Vimy, where the rest of the battalion was now located. Part of Schützen-Regiment 6, led by its commander, had by this time reached Acq on the Scarpe, granting the division a bridgehead over the river that had just eluded *Panzer-Regiment 25* the previous day. 7. Panzer-Division would make a brief comment on the conclusion of the battle, their diary summarising that:

> The very heavy attack of the enemy was finally wrecked through defensive fire from all batteries of Artillerie-Regiment 78, Flak-Abteilung 86 under command of Major Schrader, 3./Flak-Abteilung 59 under Capt. von Hirschfeld, one 8·8 cm. Battery of Flak-Abteilung 23 and parts of Panzerjäger-Abtei-

Close-up view of a first production batch Infantry Tank Mk. I being temporarily commanded by a rather pensive Landser. The 0.303-in. (7.7 mm) Vickers machine gun has been removed from its armoured mantlet, the slit on the underside of the mantlet being the spent cartridge ejection chute. Notice that the white nine inch square BEF recognition sign has been painted on both the inlet louvre blanking plate and the hull side plate behind it, and that the earlier design of aerial mounting bracket with clamping groove for the plate has been fitted. Also apparent is the thinness of the hot air deflector shield, for which expense has most definitely been spared. (Robert Gregory Collection)

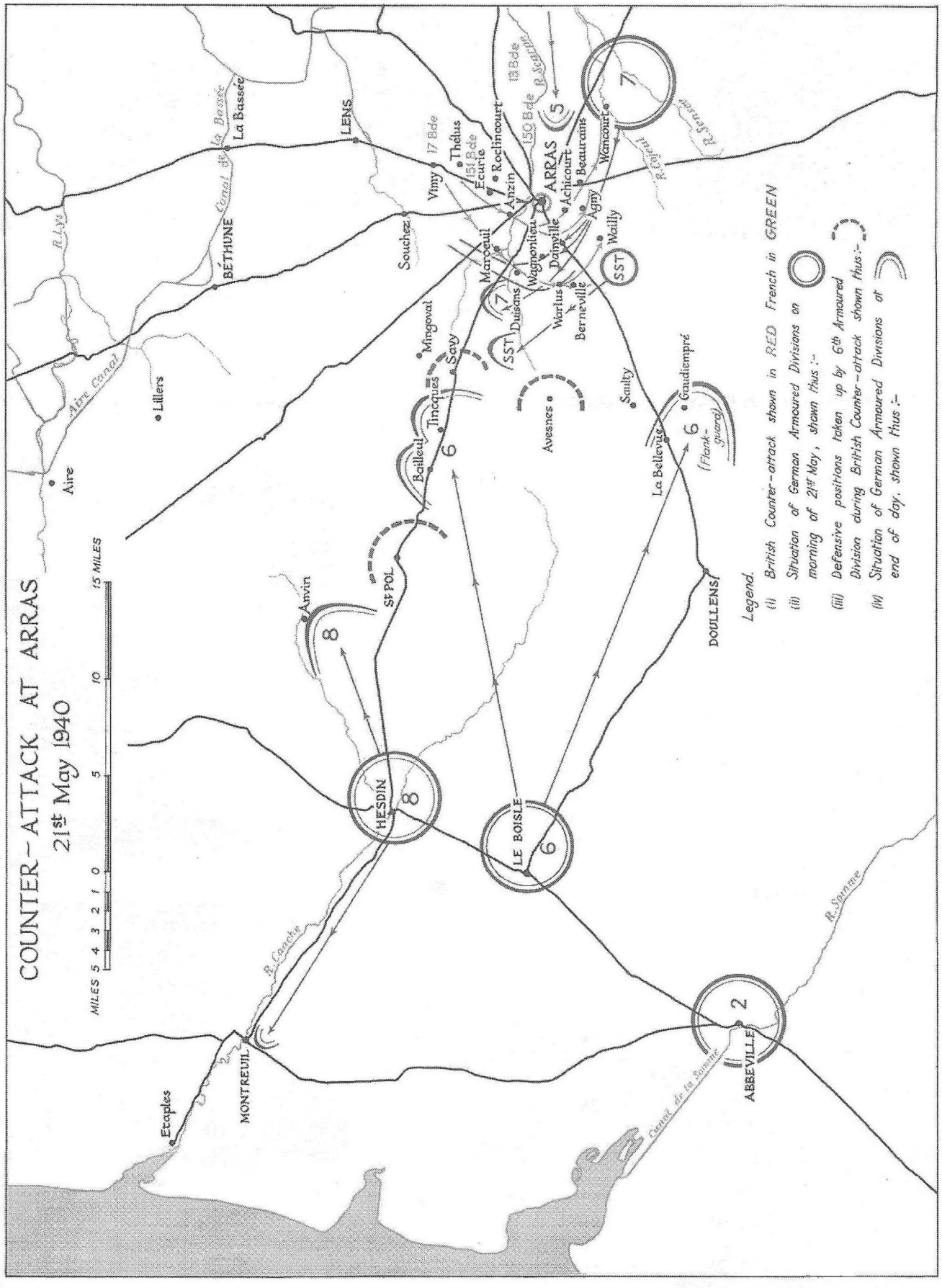
lung 42. The enemy retreated towards Arras with heavy tank losses.

During the afternoon our dive bomber units joined into the battle south west of Arras and relieved the situation which was essential to the division during the heavy battle.

The division would claim British losses as being 43 tanks, comprising 28 Infantry tanks knocked out by Artillerie-Regiment 78, one Infantry tank and seven Light tanks knocked out by various flak guns, and seven "heavy" tanks disabled or destroyed by Panzer-Regiment 25, although these figures may have included French losses, some of which had been due to friendly fire. They also claimed British personnel losses as 50 killed in action and 200 captured, which was a severe underestimate, while their own losses were acknowledged as 89 killed in action, 116 wounded in action, and 173 registered as missing. It should be recalled that the British claimed to have captured 400 Germans, although these may not have all belonged to 7. Panzer-Division, some prisoners possibly coming from the *SS-Totenkopf*-Division. The *14. (Panzer Jäger) Kompanie* (14th (Anti-Tank) Company) of *SS-Totenkopf-Infanterie-Regiment 3* had rather hopefully claimed that four of their 3.7 cm Pak anti-tank guns had accounted for fourteen of the British tanks knocked out in the vicinity of Mercatel. Their own losses had been eight killed (including the company commander) and another eight wounded, with two of their guns and four vehicles having been destroyed. The Germans did not acknowledge any tank losses extra to those suffered by Panzer-Regiment 25 in their engagements around Duisans and Warlus, although the British had claimed to have knocked out several tanks during their main advance. Overall, although the Germans had successfully checked the British attack well before its main objectives, the British had also stymied Rommel's attempt to seize the high ground north of Arras, and so honours from the battle were more or less even. The progress of *XV. Armeekorps* (XV Army Corps), of which *7. Panzer-Division* was a component, had also been temporarily arrested, it having for the first time to adopt a defensive posture and call forward supporting infantry. The British attack had made a profound psychological impact, with Rommel's superior, *Generaloberst* Günther von Kluge, the commander of *4. Armee* (4th Army), conceding that "today was the first day in which the enemy scored a result." According to Robert Cracroft, at about 0100 hours the following morning, 22nd May, "the Bn. was greeted by a burst of M.G. fire from a tank in the Bde Rally near ECURIE. As far as the 4th Bn. was concerned these were the most welcome shots fired during the Battle of ARRAS." Peter Vaux claimed that a number of stragglers were picked up on the withdrawal from Achicourt, although he became lost and did not rejoin the unit until his return to England. William Armit would recollect of the day's events that:

Most of our tanks were knocked out by hits on the tracks or were set on fire by sparks as bullets passed through non-armoured bins into stores and waterproof clothing. Our armour stood up very well. It was quite an experience seeing a gun training on you and wondering if the shot was going to come through — and a relief when it did not!

In the case of 7 RTR, the Infantry Tank Mk. I's of Charles Bell and Ernest Miles managed to make it back to Vimy, despite the damaged suspension bogie on Bell's tank causing its track to shed no less than five times. Both of these tanks had been under continual fire from both the air and ground, the unit's citation for both crews stating that "evidence of the punishment they had taken was shown by the fact that at the end of the day their tanks showed more signs of the fight than any others in the Company." The tank of 2nd Lieutenant Harry Barker had succumbed to mechanical issues during the battle, leading him to withdraw it and incorporate it in a roadblock at Arras. Barker would occupy this position for two days, reputedly killing a large number of enemy personnel in the process, prior to acting as a liaison officer for the headquarters of Petreforce. An interrogation of fourteen prisoners of Schützen-Regiments 6 and 8 conducted by the 50th Division at 0400 hours revealed that the previous day's events were the first serious fighting these Germans had experienced since the campaign in Poland in September. The prisoners also stated that the British tanks had "inflicted heavy damage on [an] M.T. column, which included some wireless trucks". The Infantry Tank Mk. I of Frederick Kitchen had managed to limp back as far as Arras, despite having been partially disabled, although an attempt to rescue the broken down tank of his section commander had failed due to intense enemy artillery and small arms fire.



Map from the Official History showing the broad sweep of the attack at Arras and the German reaction, with elements of both 6. Panzer-Division and 8. Panzer-Division being redeployed rearwards to thwart any larger British incursion.

5. AFTER ARRAS

While the fighting in Arras had been playing out, even more momentous events had been taking place at the higher levels, with the French commander-in-chief, Maurice Gamelin, having been replaced by *général* Maxime Weygand on 20th May and the French government having been reconstructed, with the prime minister Paul Reynaud instead becoming the minister for defence and war. Weygand had overseen a series of conferences during 21st May in which various schemes had been mooted to cut the German corridor in the south, but these had produced no firm resolution. This was partly because of the poor condition of the French 1e armée, as argued by *général* Billotte, and partly because of the absence of Lord Gort, as circumstances had prevented him from meeting up with Weygand. These conferences were concluded in tragedy as *général* Billotte would be fatally injured in a car accident on the way back to his headquarters, this leaving a temporary vacuum at the top of the 1st Army. During 22nd May the 1st Army Tank Brigade, including the remnants of 4 RTR and 7 RTR, returned to the Vimy area, the move being conducted with the tanks and vehicles being widely spaced into small groups. The Brigade headquarters recorded that German aircraft were very active during the move with roads being continually strafed and bombed. Vimy was reached during the afternoon, the two battalions spending the rest of the day reorganising, and maintaining and repairing the surviving tanks. An audit of these revealed that 4 RTR had retained sixteen Infantry Tank Mk. I's, of which four were unfit, and four Light tanks, of which one was unfit. 7 RTR had managed to bring back thirteen Infantry Tank Mk. I's, six Mk. II's, and four Light tanks, all of which were fit. This meant that of the 100 Infantry tanks that had started the campaign, only 35 remained with the unit, the rest having been lost in battle or having succumbed to mechanical defects or wear. Casualties for the two battalions in personnel were estimated to be 226 killed, wounded or missing, of which 14 had been officers. During the night the 1st Army Tank Brigade took up defensive positions, with 4 RTR being concealed in trees on Vimy Ridge, on the western side of the road down to Arras, their role being to counterattack a potential enemy advance from the direction of Arras, or from the west of Arras. The battalion had fourteen fit A11's by this juncture, while in the case of 7 RTR their Mk. I's still numbered thirteen, although another fit Infantry Tank Mk. II had appeared bringing the total up to seven, and the brigade total of Infantry tanks to 36. The latter battalion were stationed on the high ground east of Souchez, three miles (5 km) to the northwest of Vimy, in order to protect the right flank of 50th Division's reserve position. The brigade workshop had posted its recovery section to Le Petit Vimy, and these had achieved a modicum of success, as:

> Recovery section brought in two Mark I and two Mark II 'I' Tanks recovered near Arras and work on the repair of these was commenced immediately they came in. This recovery work was chiefly done in the evening of 21st. and through the night of 21st. and 22nd. Much of the recovery was done in positions exposed to enemy machine gunfire and the recovery section was at all times subject to bombing attacks. The slow movement of a scammell tractor towing a heavy disabled tank, along roads packed with refugees, afforded good conditions for aerial interference with our recovery and the scammells were repeatedly machine gunned from the air.

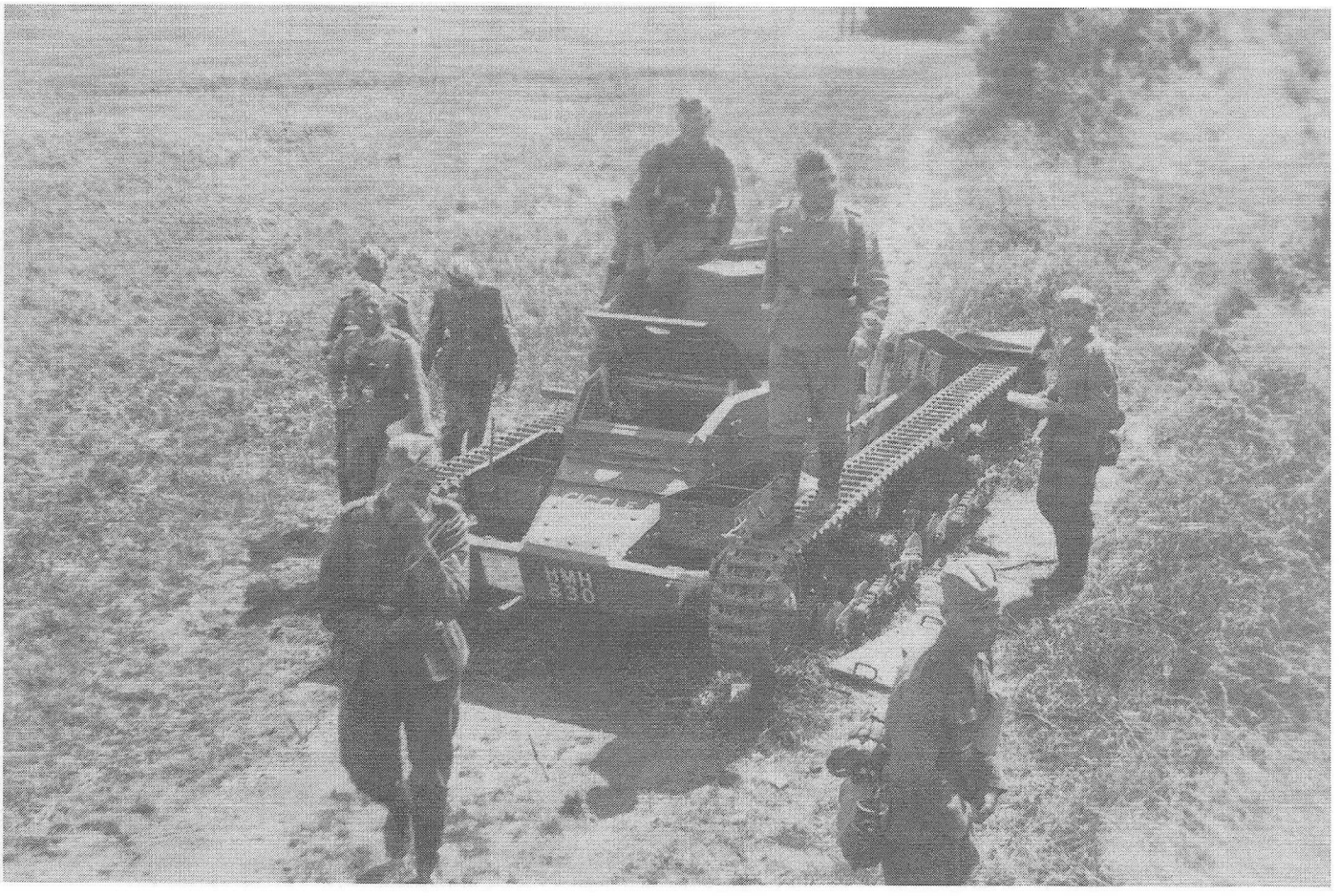
Most of the tanks lost during the previous day would have been impossible to recover as the ground on which they had been disabled was now in enemy hands, while the inadequate resources of the recovery section, with only three tractors and trailers, severely limited their efficacy. Indeed it was now becoming apparent that the resources of the workshop were inadequate for servicing the brigade, this being yet another example of how the Army had underestimated the scale of support necessary for armoured warfare. Not all was well with the repair of the tanks that had been brought down to Mazingarbe from Tressin, as the workshop had:

> Finished changing engine of 'I' tank Mark I brought from the chateau Hem and it was all ready to go back to its Battalion except for a gear selector lever which we were advised was waiting for our collection at A.O.D. In spite of numerous requests for advice during the past few days for the location of A.O.D. we were still without information and we were therefore unable to collect the lever.

The Advanced Ordnance Depot had in fact been located in Arras, but by this time had already fled and was currently in the process of crossing the Seine, after which it would be split up into sections for reassignment to other units. As part of the evacuation, an RAC group of four officers and 150 men had been sent to remove 14 Infantry Tank Mk. I's, 37 Light Tank Mk. VI's, and 75 carriers (all denuded of armament)

from storage at Saint-Laurent-Blangy, which was just to the east of Arras, although only a partial removal of these vehicles had been effected. It would have been scant consolation to the brigade workshop that gear selector levers were one of the very few components that the AOD had been requested to salvage before it evacuated. The gear selector lever (located directly on top of the gearbox) for the Infantry Tank Mk. I was proving to be a notably fragile component, whose failure could easily disable a vehicle. Later in the day, the commander of the workshop, Major Rodney Shields, was warned of the potential approach of German forces, and so he set about providing defences for the farm within which the workshop was located. To this end a pair of Mk. II tanks were taken from the workshop and positioned one each at the main entrance and the main exit, these being so located that work could continue on them while they kept watch. A single Mk. I tank, which was deemed a "runner" was held in reserve for a pursuit role should the opportunity present itself. These tanks were manned by personnel from the 1st Army Tank Brigade, the convention at this time being that non-officer crews remained with their machines while they were being repaired.

During the early morning of 23rd May, Harold Franklyn ordered Douglas Pratt to coordinate the "touch defence" of the entire Vimy area with the French. To this end Pratt visited lieutenant général René Prioux, the overall commander of the French *corps de cavalerie* (cavalry corps) in Le Petit Vimy and later the commander of the 1re division légère mécanique (1re DLM), *général de brigade* François Picard, who had recently arrived in the area. From Picard's subordinate, lieutenant-colonel Marie-Joseph Pinon of the divisional 18e régiment de dragons, Pratt learned that there were approximately 30 Somua S35 and 24 Hotchkiss tanks in the triangle bounded from Souchez due south to Neuville-Saint-Vaast, and then west to Mont-Saint-Éloi. He therefore agreed with Picard that ten of the Somua tanks would support the British 17th Infantry Brigade located at Écurie, and another ten would monitor Mont-Saint-Éloi, with both groups of tanks adopting a counter-penetration role. The remaining Somuas would be held in reserve, while the Hotchkiss tanks would be concentrated around Souchez to the rear. At 0930 hours 7 RTR would move further west to the high ground on the other side of Souchez, to cover the substantial French military cemetery of Notre-



First production batch Infantry Tank Mk. I Giggle *of 'A' Company, 7 RTR, which was abandoned on the Notre-Dame-de-Lorrette ridge on 23rd May. The lids of the stowage boxes have been removed and the contents removed.* (Private Collection)

Dame-de-Lorette, just to the north of the village of Ablain-Saint-Nazaire. About an hour and a half later 5. Panzer-Division, having crossed the Scarpe over the Pont du Gy at Étrun, attacked Mont-Saint-Éloi, turning the right (*i.e.* western) flank of the 17th Infantry Brigade. In response, Douglas Pratt ordered the new commander of 7 RTR, Major Freddy Garrett, to move south through Souchez, leaving one of his three companies there facing north and northwest. Both men then went to reconnoitre a suitable position to block the German advance, which was observed to be moving north from Mont-Saint-Éloi, the location chosen being a ridge to the south of Carency (to the southwest of Souchez) that would flank the approaching enemy. In the event, Garrett nominated his 'D' Company to remain at Souchez and took 'A' and 'B' companies forward to engage the Germans.

On reaching the designated fire position, the two companies were joined on their right flank by Somua tanks from 1re DLM, these presumably being the ten that had been detailed to watch over Mont-Saint-Éloi. The battalion recorded of the enemy tanks that "numbers were knocked out by our 2 pr. fire", with the Germans being successfully forced to withdraw, although Freddy Garrett was killed while directing the fighting from outside his tank. 'A' and 'B' companies then returned to rally at Souchez, being joined by 'D' Company whose commander, Major George Parkes, then took over command of the battalion. Parkes had received information from the French of another potential enemy attack towards Ablain-Saint-Nazaire, and so moved his tanks to the ridge at Notre-Dame-de-Lorette, where an observation post near the cemetery spotted a stationary German motorised column to the southwest between Villers-au-Bois and Mont-Saint-Éloi. Before the brigade headquarters could be warned, this column was observed to have commenced moving northeast in the direction of Souchez. Parkes had five sections of tanks available, and so he directed two of these to remain holding the ridge at Notre-Dame-de-Lorette, and two more to hold blocking positions on the outskirts of Souchez. He himself would lead the last section through Souchez towards Carency in order to meet the German advance, encountering enemy anti-tank guns that were covering a burning barricade on the outskirts of Carency. These guns were successfully engaged by the 2 pounders, while a group of dismounted infantry assembling at the foot of the Notre-Dame-de-Lorette ridge were sprayed with fire from the Vickers machine guns. Captain Patrick Ward made a notable contribution in this regard, his Infantry Tank Mk. I being subjected to anti-tank fire from close range. Major Parkes was nonetheless aware that a much larger enemy force was in the area, and so he returned to the ridge at Notre-Dame-de-Lorette, leaving only one section blocking access to Souchez. Corporal Christopher Davies, the gunner of an Infantry Tank Mk. II, had particularly distinguished himself during the two actions at Souchez, keeping up steady and accurate fire even when his tank had been hit repeatedly at close range, and on one occasion set on fire.

Although 4 RTR had not been engaged in any fighting, German aircraft had been active all day, with dawn reconnaissances being followed by heavy bombing and strafing along roads, villages and identified troop locations, every unit of 1st Army Tank Brigade having suffered consequent casualties. During the afternoon it was decided to move the 'B' echelons and spare personnel north of Lens, which was itself five miles (8 km) north of Vimy, with orders being issued to commence departing at dusk. Despite this partial retreat, Frankforce issued instructions that the fighting echelons would continue to defend the ground they currently held. Meanwhile at Notre-Dame-de-Lorette 7 RTR had to watch rather helplessly as enemy infantry skilfully encroached on their position, and so as dusk approached George Parkes decided to withdraw east to the ridge at Givenchy-en-Gohelle, which overlooked Vimy to the southeast, this being in accordance with instructions previously given to Freddy Garrett. However, while this move was in progress a German tank and infantry attack was made against the ridge at Givenchy, this being engaged by two of the battalion's Infantry Tank Mk. II's. One of these tanks was positioned forward of the ridge, and the other on a flank at the foot of the ridge, their fire providing cover for the retirement of the rest of the battalion. The battalion's account of this action stated that:

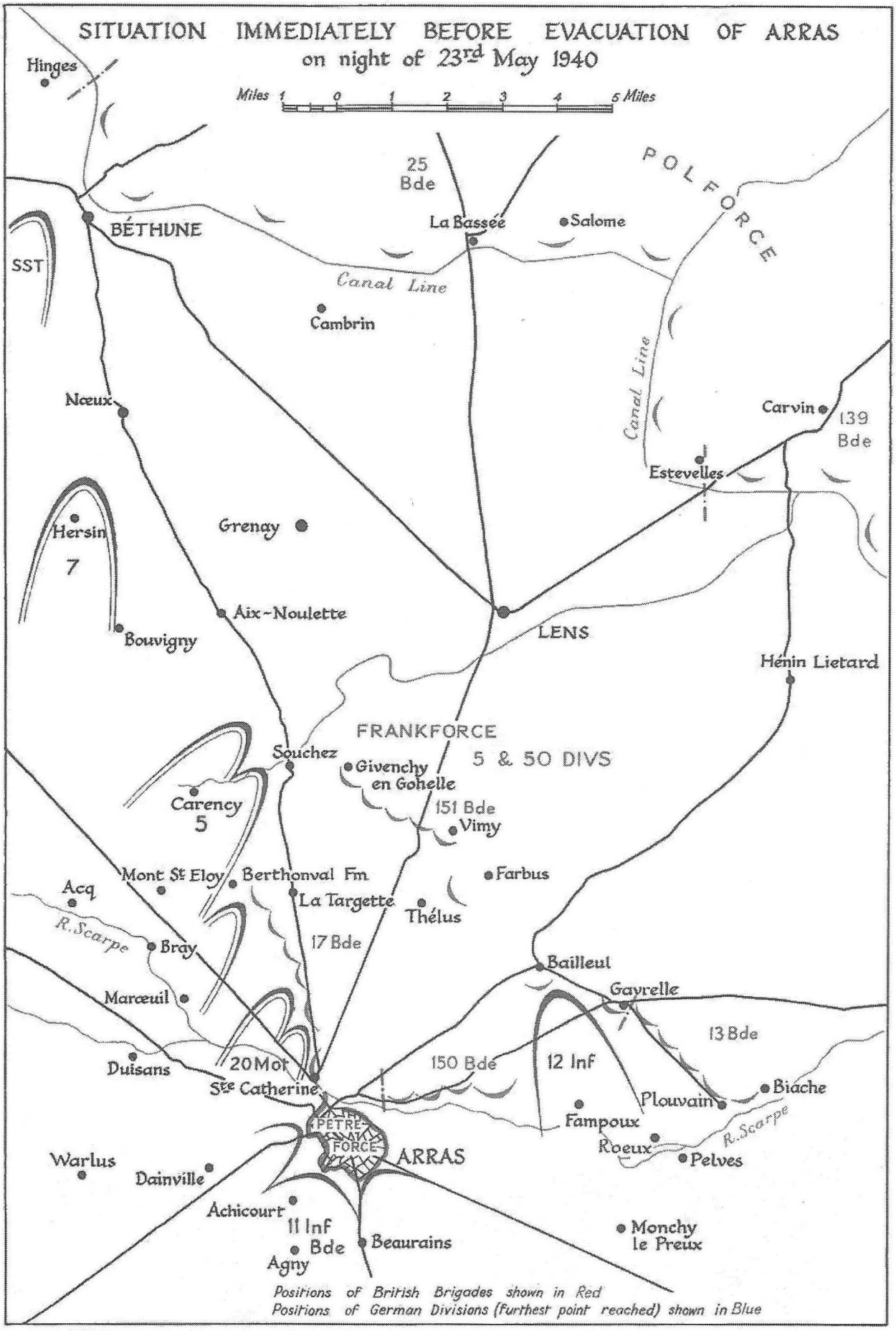
> Both these tanks had to be abandoned eventually, due to serious mechanical trouble (gearbox and rackhams) and consequent inability to get away, but all ammunition was expended first. Enemy tanks were of light and medium type, and four or five were knocked out. It was not easy to observe fire effect owing to the fading light, and towards the end fire was confined in the direction of the enemy gun flashes.

The six speed Wilson epicyclic gearbox and Rackham steering clutches of the A12 were its most troublesome components, these being gradually ameliorated during the tank's service life. One of the evacuees from these machines was Trooper Hector Smith, who had distinguished himself in his efficiency as loader, on one occasion restocking with ammunition from another tank. Also lost during the evacuation from Notre-Dame-de-Lorette was the Infantry Tank Mk. I of Sergeant Leslie Harvey, which had been engaged at close range by the enemy tanks and set on fire. Nonetheless Harvey had managed to evacuate with

Another view of Giggle, *revealing that the driver's periscope and head pad have been removed. The driver's rearview mirror was not fitted in France, as its offside position was not suitable for driving on the right hand side of the road, its stand generally being folded down, as can be seen here.* *(Robert Gregory Collection)*

his driver and escape under the cover of darkness. This latest German attack, which was on the right flank of the combined French and British position, was considered to be sufficiently powerful to endanger Lens, while the main road bridge in that city had been destroyed from the air. As a consequence, at 2300 hours Harold Franklyn verbally ordered the 1st Army Tank Brigade to withdraw immediately, with each unit to extract itself as best it could. The brigade was to retreat to an area northwest of Carvin, eight miles (13 km) northeast of Lens, going around the southeast of Lens via Hénin-Liétard in order to utilise intact bridges. The withdrawal was conducted in good order during the night, as the Germans characteristically ceased their activity during darkness. Extra lorries that had been provided for the brigade's RASC company were used to transport the crews of knocked out or broken down tanks, these also replacing vehicles that had been destroyed by enemy bombing. The withdrawal continued into the early hours of 24th May, the brigade headquarters remarking that the roads were occasionally badly congested, especially in Hénin-Liétard due to road blocks and houses burning from enemy air action. By the morning, 1st Army Tank Brigade had collected itself four miles (6 km) northwest of Carvin at Phalempin after a march of approximately twenty miles (30 km), it spending the remainder of the day resting, refitting and reconstituting.

Meanwhile the 1st Army Tank Brigade Workshop had been ordered to move around the north of Lens from Mazingarbe to Bauvin, ten miles (15 km) to the northeast, this being completed during the early morning of 23rd May, with workshop accommodation again being found on a farm. Once the workshops stores and vehicles had been dispersed, the recovery tractors had been sent back to Mazingarbe to retrieve the tanks. This process went on for the rest of that day and into the night, although an attempt to bring back a Mk. I tank by having it towed by another (repaired) one resulted in the fit tank breaking down and itself needing to be recovered. The recovery effort was suspended when the bridges over the Canal D'Aire near Bauvin were blown, the outcome being that a pair of Infantry Tank Mk. II's and a single Infantry Tank Mk. I had to be left behind. The workshop's diary would ruefully record that "A recovery party went out late at night to try to recover the remaining tanks at Mazingarbe,


SITUATION IMMEDIATELY BEFORE EVACUATION OF ARRAS
on night of 23rd May 1940
Miles 1 0 1 2 3 4 5 Miles
Hinges
25 Bde
POLFORCE
BÉTHUNE
La Bassée
Salome
SST
Canal Line
Cambrin
Canal Line
Nœux
Carvin
139 Bde
Estevelles
Hersin
7
Grenay
Aix-Noulette
LENS
Bouvigny
Hénin Lietard
FRANKFORCE
5 & 50 DIVS
Souchez
Givenchy en Gohelle
Carency
5
151 Bde
Vimy
Mont St Eloy
Berthonval Fm
Farbus
Acq
La Targette
Thélus
R. Scarpe
Bray
17 Bde
Bailleul
Gavrelle
Marœuil
13 Bde
Duisans
20 Mot
Ste Catherine
150 Bde
12 Inf
Biache
Plouvain
Fampoux
PETRE-FORCE
ARRAS
Roeux
R. Scarpe
Pelves
Warlus
Dainville
Achicourt
11 Inf Bde
Beaurains
Agny
Monchy le Preux
Positions of British Brigades shown in Red
Positions of German Divisions (furthest point reached) shown in Blue

Tank of 10th Section, 'B' Company, 7 RTR, on the Notre-Dame-de-Lorette ridge, the tower and dome of the military cemetery being visible in the background. The lid of the offside stowage bin is open, while the back plate has been holed, probably by a 3.7-cm-Pak or tank-mounted 3.7-cm-KwK, just above the "G" of the name Garbo. *It is notable that abandoned tanks were quickly stripped of their wireless sets and aerials, although it is not clear whether these were evacuated by the crews or purloined by the Germans. This view shows the offset position of the winch drive output, the small rear cover plate rotating to the side to allow the drive shaft to be connected.* *(Private Collection)*

taking a long detour to pass the canal, but the party was later turned back by a British Officer, who said that it would be highly unsafe to proceed further towards Mazingarbe." However, another pair of Infantry Tank Mk. I's had been recovered from Vimy and Marœuil earlier in the day along with a Light Tank Mk. VI B and a 3 ton truck. As such, the workshop would retain a pair of Infantry Tank Mk. II's, three Infantry Tank Mk. I's and a Light Tank Mk. VI B. There was considerable anxiety within the workshop about being out of touch with brigade headquarters, this presenting the possibility that they might have to abandon more tanks were they to suddenly receive orders to move. During the early hours of the morning of 24th May Major Shields had visited the headquarters of the 25th Infantry Brigade, who ordered the workshop to move thirteen miles (21 km) north to Sailly-sur-la-Lys, this journey being conducted through the usual heavy congestion. Further instructions from local forces would result in the workshop column trekking another eleven miles (18 km) over the Belgian border, where detachments were set up to work on the tanks at Ploegsteert and Kemmel (Heuvelland), these two villages being six miles (10 km) apart. These locations were in turn approximately twenty miles (30 km) north of Carvin, where the 1st Army Tank Brigade itself was reorganising.

Although the Germans had taken Arras and seized their first bridgeheads over the Canal Line, their unprecedented success thus far had created its own dilemmas. On the evening of 23rd May the commander of Heeresgruppe A, *Generaloberst* Gerd von Rundstedt, began to address his lingering concern over the perceived vulnerability of his flanks, the 25 mile (40 km) wide corridor that his force had opened having already been threatened by the British attack from Arras and a subsequent minor French attack towards Cambrai. The possibility also remained of a thrust by the French from the south. As the attempts by Rundstedt's XIX Corps to seize Boulogne and Calais had yet to succeed, and as his Somme flank was not yet secure, he ordered his advanced panzer formations to halt were they were. This decision was approved the following morning by the *Führer* himself, Adolf Hitler, on a visit to von Rundstedt's headquarters. Hitler considered that any attack mounted on the remaining

Allied perimeter had to be made with infantry, while the armoured formations had to be conserved for future operations south of the Somme. As such it would be Heeresgruppe B who would now press towards the coast as the hammer, while Heeresgruppe A would hold their front and act as the anvil, with the Luftwaffe being given the final honour of finishing off the remnants of the enemy. After Hitler had departed, von Rundstedt issued a halt order, under the name of the *Führer*, for his forces to deny the Canal Line to the Allies although not to cross it. This instruction perplexed and frustrated his divisional commanders, who would spend the 24th May in the repair and maintenance of their tanks and vehicles.

The reorganisation of the remnants of the 1st Army Tank Brigade was completed on 25th May, with the formation of a composite unit labelled the 4th/7th Battalion (4/7 RTR), which was placed under the command of George Parkes. This accommodated all the remaining fit tanks, which included eighteen Infantry Tank Mk. I's, of which twelve came from 4 RTR and six from 7 RTR, and two Infantry Tank Mk. II's from 7 RTR, of which one was deemed to be "doubtful mechanically". This latter machine was driven by Lance-Corporal Albert Hamilton, its nearside engine having failed before going into action at Arras. Eight Light Tank Mk. VI B's were also available, these coming four each from the two original battalions. The 1st Army Tank Brigade was thenceforth to consist of a Fighting Group, comprising the brigade headquarters and the 4th/7th Battalion, and an Administration Group, which was to include the RASC company, the Field Ambulance, and the brigade workshops. This latter group would also include the administrative personnel of 4 RTR under Major Holford-Walker and those of 7 RTR under Captain Gardner. The Infantry Tank Company would be commanded by Captain Kenneth Harris of 7 RTR, his second-in-command being Captain Tighe of 4 RTR. Harris was to command from a single A12, his company comprising five sections of three A11's each, and a single Light Tank Mk. VI B operated by the company Reconnaissance Officer, 2nd Lieutenant Grantham. There would also be a company reserve of one (mechanically impaired) A12 and three A11's under 2nd Lieutenant Knott. The remaining seven Light Tank Mk. VI B's would be collected in a Light Tank Section, with one being allocated to its commander, 2nd Lieutenant Fry, and the other six being divided into two sub-sections. Six carriers from 7 RTR would be allocated to the 48 spare crewmen, these necessarily being over-burdened. Major Parkes' staff would comprise an adjutant, Captain Jock Holden, a Technical Officer, Captain Gibbon, as well as a Liaison and a Medical Officer. These would all travel in Parkes' staff car, which was one of 22 vehicles allocated to the unit, these including fitters lorries, petrol, water and ammunition trucks, a wireless truck and a lorry for the Medical Officer. Eight motorcycles were also provided for the battalion dispatch riders. The eleven men that comprised the LAD all came from 4 RTR, while the six unit fitters came equally from each of the original battalions, these being part of the more than fifty support and administrative personnel attached to the unit.

The morning of 25th May was marked by the arrival of Vyvyan Pope, who gave verbal orders for all available tanks to move back to the Orchies area, fifteen miles (25 km) due east of Carvin, where they were to come under the command of 3rd Corps, who had arrived to augment the BEF during April. On arrival at Orchies, Douglas Pratt attended a conference at 3rd Corps headquarters where plans were being made for the participation of the 5th and 50th divisions in a counter-attack by 5^{e} *corps d'armée* (5th Army Corps) of 1^{e} armée towards Cambrai, which was 25 miles (40 km) to the south. This long-awaited operation was anticipated to unfold over three days, as part of the Weygand Plan to cut the corridor formed by Heeresgruppe A, a complementary attack also being planned from the south. The resurrection of this initiative was inspired by the lull in German activity, and from reports from prisoners that the enemy in the Cambrai vicinity had switched to a defensive posture. The tanks of the 4th/7th Battalion were to be divided between the two British divisions, with two sections of Infantry Tank Mk. I's (*i.e.* six tanks) comprising the spearhead of each division. During the afternoon however, sounds of battle emanating from the south and west could be heard approaching, until artillery shells began to range on the villages occupied by the 1st Army Tank Brigade. It was accordingly decided to move twenty miles (30 km) northwest after darkness fell, and relocate to Ennetières-en-Weppes, west of Lille, although the 4th/7th Battalion was to remain in the Orchies vicinity, moving to the assembly area for the counter-attack. This was located in the Bois de Flines, five miles (8 km) to the southwest of Orchies, the composite battalion arriving there in the early hours of the morning of 26th May, with George Parkes recalling that:

> Owing to the darkness, shortage of maps, and the need for constant diversions round barricades and blocked villages, progress was slow, but eventually the battalion was laagered in the BOIS DE FLINES by first light. Three D.R.'s [Dispatch Riders] lost their way and were missing.

The above passage once again demonstrated the perilous nature of depending on dispatch riders for communications, as these could be prone to interruption from accidents, enemy action, obstruction by refugee columns and roadblocks, or simply becoming lost in the increasingly fluid strategic situation. Also on 25th May,

Early second production batch tank T5559 Gort *of 'B' Company, 7 RTR. This photograph gives a good view of the spade grip for the driver's periscope, which had been advocated in MEE report A45/12. Also clearly visible is the combined bogie and return roller mounting utilised on production vehicles, the track having been broken by the Germans.* (Private Collection)

the 1st Army Tank Brigade Workshop in Belgium was seeking assurances from 3rd Corps that they would be able to remain in their current location, as:

> At this date we badly needed three or four clear days to repair the tanks in the workshop, as each move so far had necessitated the partial reassembly of the tanks under repair, to enable them to be towed to the next workshop. Certain jobs could not be tackled at all without some assurance that we would be left undisturbed at least in one place.

No such confirmation could be given, although the unit were at least provided with a five ton lorry to carry ordnance spares, this thereby freeing up one of the recovery trailers for immediate usage. Major Shields also managed to obtain the whereabouts of the brigade headquarters, and accordingly

proceeded to Phalempin to meet up with Douglas Pratt, although this proved unsuccessful as the headquarters itself had already departed to Orchies. Nonetheless the brigade RASC company did manage to locate the workshop at Kemmel and provide it with much needed rations. Meanwhile, the will to mount the attack against Cambrai had gradually dissipated due to the cancellation of the complimentary French attack from the south, and the increasing doubts among senior French commanders as to the likelihood of success. Even before he had learned of these hesitations, however, Lord Gort had ordered the 5th and 50th divisions to abandon preparations for their role in the attack and transfer north to plug a dangerous gap that had opened up in the Belgian line between Menin and Ypres. This breach had been made by the Germans in order to create a northern pincer against Dunkirk, which was to accompany the one that was moving along the coast from the south.

At dawn on 26th May the commander of the Infantry Tank Company, Kenneth Harris, set out with his section commanders to find the headquarters of the 5th and 50th Divisions, who they were supposed to accompany in the forthcoming attack, while George Parkes set out for the headquarters of 3rd Corps. These initiatives were course unsuccessful as these formations had long departed, although Parkes did meet the 1st Army Tank Brigade's commander, Douglas Pratt, on returning to the Bois de Flines. Pratt had returned to Orchies having established the brigade headquarters not at Ennetières-en-Weppes, but at nearby Escobecques, also just west of Lille. Meanwhile his Brigade Major, Bernard Cracroft, made the short journey north from Escobecques to GHQ's Command Post at Prémesques, where he was informed by Vyvyan Pope that 1st Army Tank Brigade were to retire to Dunkirk immediately for evacuation to the United Kingdom. Indeed the decision to evacuate the BEF had now been taken by Lord Gort, after learning from the Secretary of State for War, Anthony Eden, that there was no longer any prospect of the French armies in the south reaching the Allies north of the Somme. Gort had therefore planned a staged withdrawal to the coast, which would take place over the coming three nights. The composite 4th/7th Battalion was to remain behind for the present and continue to report to 3rd Corps, who were now established at Seclin, six miles (10 km) south of Lille. They were also to be provided with details from 1st Army Tank Brigade's RASC company and field ambulance, who would accordingly not partake in the brigade's immediate evacuation. According to 1st Army Tank Brigade's headquarters, they had still not been informed of the cancellation of the counter-attack towards Cambrai, with the latest orders from GHQ only reaching the 4th/7th Battalion at around midday. The commander of the Infantry Tank Company, Kenneth Harris, was consequently tasked with arranging the move of the unit to 3rd Corps at Seclin, with George Parkes accompanying Douglas Pratt back to Escobecques to organise their administrative details (*i.e.* the RASC and ambulance).

The journey of Parkes and Pratt to Escobecques was delayed by intensive bombing, although they managed to reach the brigade headquarters at 1330 hours, where Parkes briefed the RASC detail. He then set off in his staff car an hour later for 3rd Corps at Seclin, arriving at that town at around 1615 hours, where there was no sign of the Corps headquarters, or that of any other formation. Seclin itself was being heavily bombed, with Parkes remarking that "The impression gathered was that there was a general withdrawal." After a period of waiting, Parkes saw Lieutenant Grantham arrive with five Light tanks, Grantham reporting that the 4th/7th battalion had been bombed on leaving the Bois de Flines. Parkes then sent Grantham back along the route to see if there was any sign of the arrival of the slower Infantry tanks, this revealing no sign of them. He therefore ordered Grantham and his tanks directly to Dunkirk in order to contact the 1st Army Tank Brigade's headquarters, the main body of the brigade having moved off to Dunkirk during the afternoon. Parkes had arranged for a dispatch rider to be available at Seclin to pass any orders issued by 3rd Corps back to the supply detail at Escobecques, although they had failed to arrive. Parkes did however encounter a staff officer from GHQ, who informed him that the 3rd Corps headquarters was now located at Lille. On subsequently arriving at Lille, he was informed by the aforesaid headquarters that the 4th/7th Battalion were now to assist the 2nd Infantry Division. However, Parkes explained that in the absence of any information as to its current status, he could not confirm whether the battalion could still be regarded as a fighting unit. He nonetheless undertook a personal reconnaissance of the route from the Bois de Flines, where he initially met "two or three" Infantry tanks, which he ordered on to Dunkirk to join the Light tanks of Lieutenant Grantham. Some time later more tanks arrived, this prompting Parkes to ponder the recall of the tanks he had sent on to Dunkirk, the matter being decided by the arrival of Vyvyan Pope from GHQ. Pope ordered that all the available tanks should be collected together and directed to the headquarters of the 2nd Division near Richebourg, 20 miles (30 km) west of Seclin, who were attempting to reduce the enemy bridgehead on their sector of the Canal Line. The battalion's adjutant, Jock Holden, was sent to obtain orders from the 2nd Division, while Kenneth Harris, who was also the second-in-command, was instructed to recall all the tanks that had already moved on towards Dunkirk and redirect

them to Richebourg, where he was also to reconnoitre an assembly area. Parkes recalled that:

> The 2nd in command was able to report that in spite of the fact that the column had been heavily and systematically bombed on leaving the BOIS DE FLINES the casualties had been surprisingly few. One I tank Mk. I had been overturned completely by a bomb (four small bombs tied together) which dropped just in front of it, and one light tank destroyed by a similar bomb. One Mk. I tank had to be abandoned with gear-box trouble, and two or three had missed their way.

It was Harris himself who was credited with successfully extracting the tanks from the woods during the above-mentioned aerial assault, it being stated in the unit citation that "By his cool action on this occasion, he undoubtedly saved many lives." In the event, thirteen Infantry Tank Mk. I's were collected together, along with the battalion's RAOC Light Aid Detachment, these being led by Parkes in his staff car in a tightly bunched column so as to avoid stragglers. This was necessitated by the fact that very few maps were available, and there were no available dispatch riders. Diversions had to be made firstly around Seclin which was by this time burning intensely, and secondly to cross the Canal de la Deûle, the bridge near Wavrin having been mined.

Elsewhere, during the morning of 26th May the brigade workshop detachments at Kemmel and Ploegsteert had intended to stay in situ to continue their repairs, despite the approaching sounds of battle, although just before noon they received a message from the brigade headquarters advising them to evacuate all their disabled tanks to Bergues, just outside Dunkirk. Two of the Scammells were immediately sent off to Bergues, which was 23 miles (37 km) to the northwest, each one towing a Mk. I tank. The workshop's main body did not set off to the coast until the late afternoon, arriving at 1900 hours, the decision being made to bivouac outside the town. This was done in order to effect the rendezvous with the brigade headquarters, which was to occur east of Bergues, and also to avoid the worsening conditions in Dunkirk, where the congestion of men and vehicles awaiting evacuation was being subjected to regular bombing raids. It was also hoped to set up the workshop for a final time and complete the repairs of the six tanks still in their possession. Two farms were eventually located to site the workshop, with two Infantry Tank Mk. I's and the Light Tank Mk. VI B having already been brought up from Kemmel, the Mk. I's by the aforementioned Scammells and the Light tank having been towed by a machinery lorry. The Scammells were then sent back to retrieve two more tanks, with the third Scammell bringing the last outstanding tank, all three machines (two Mk. II's and a Mk. I) arriving at Bergues earlier the following morning. An attempt to locate the brigade headquarters yielded the incorrect information that it had already sailed for England, as well as orders for the workshop to move to Dunkirk. Here they were to be parked in an already packed field, this yielding the protestation from Major Shields that:

> Up to this time, in spite of all the bombing the unit had seen during the last ten days, the whole unit was still completely intact both as regards men and vehicles except for the two men wounded and two men left sick at Brevel before the advance into Belgium. This it was felt was due in part, to the care which had been taken in the camouflage and the concealment of our vehicles at all previous workshop sites and to the dispersion of the vehicles which could not be properly concealed.

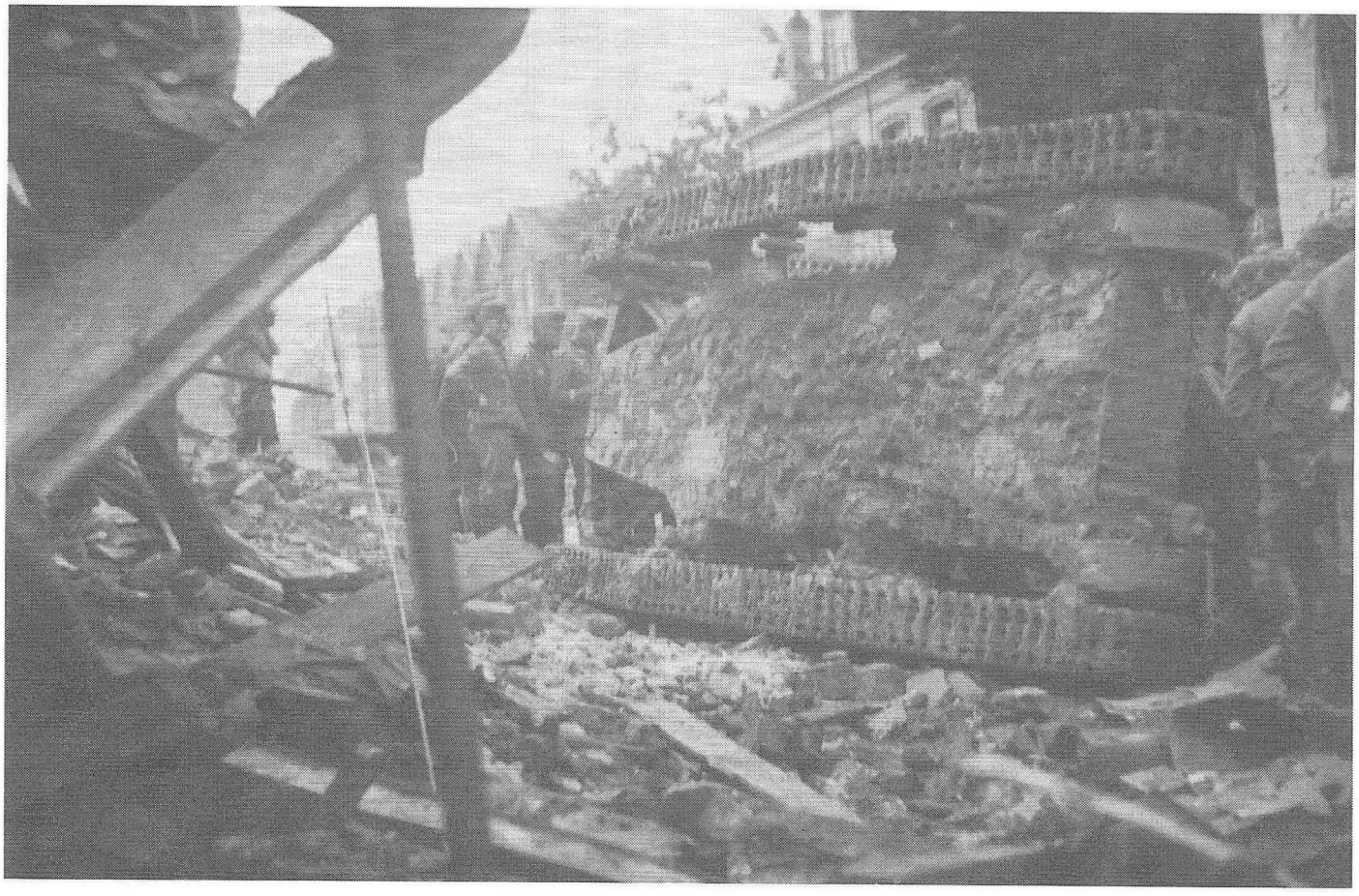
It was however also the case that the preservation of the unit was partially due to it not having been particularly heavily engaged in the recovery and repair of the brigade's tanks. Elsewhere, the 4th/7th Battalion column reached Fournes-en-Weppes, eight miles (13 km) east of Richebourg, in the early hours of 27th May. Here it halted as the vehicles were low on fuel, and neither the second-in-command nor the adjutant had returned from their respective assignments. An attempt by Parkes to locate the RASC petrol and supply detail at Bois-Grenier, six miles (10 km) to the north, was also unsuccessful, and at first light he departed to find the 2nd Division's headquarters at Bout Delville, north of Richebourg. On alighting upon this headquarters, he made arrangements for petrol to be delivered to the column later that morning. On the way back to Fournes, Parkes passed through Richebourg, where the two remaining Infantry Tank Mk. II's had been directed to, but these were not there. Unbeknown to Parkes, this pair of tanks, along with three Mk. I tanks that had been reported missing, had in fact reached Escobecques, where they had met up with the RASC petrol and supply detail. Having failed to make contact with Parkes' column via a dispatch rider, the five stray tanks had received instructions from a GHQ staff officer to report to the 5th Division for further employment. The 5th and 50th Divisions were currently protecting the northern (left) flank of the BEF between Comines and Ypres against Heeresgruppe B, as the Belgian Army in that sector was in danger of collapse. While in this location, the tank of 2nd Lieutenant John Knott of 7 RTR was ordered to protect the crossroads in the village of Sint-Elooi, midway between Comines and Ypres. Here he managed to prevent an enemy penetra-

tion accompanied by artillery fire and aerial attack, knocking out a pair of enemy anti-tank guns in the process. After having to abandon his tank he managed to extricate his crew and return them to a previously arranged rendezvous point.

George Parkes had also made contact with his second-in-command, Captain Harris, on his return journey, who informed him that the unit was to be attached to the 25th Infantry Brigade in the area of Neuve Chapelle, seven miles (11 km) further west. Although it would not be possible for the column to reach the brigade in time for their attack at 0900 hours, the commander of the brigade hoped that they could assist on their way up by engaging any enemy that might break through. The petrol arrived at Fournes-en-Weppes at 0930 hours, and while the tanks were being filled the local French divisional commander requested that they strengthen a gap in the line at Le Loup Pendu, just to the east of the nearby small town of La Bassée. The tanks were therefore moved to this position, although one had to be left behind at Fournes with gearbox trouble, with Parkes then being ordered by the 2nd Division headquarters to support the 1/7th Battalion of the Queen's Royal Regiment (West Surrey) at Neuve Chapelle. The unit moved off to Neuve Chapelle just after midday, with two tanks being ordered to follow after they had repaired their tracks, the route having been thoroughly bombed by the enemy in preparation for their attack on La Bassée, the halt order on Heeresgruppe A having been rescinded. The Panzer groups were now to push up from their existing bridgeheads over the Canal Line, further tightening the noose around the Allied armies.

On contacting the Queen's Regiment in the middle of the afternoon, the tanks of the composite 4th/7th Battalion were once more pressed to support an attack, this time at 1500 hours, although once again the tanks would not be able to reach the start line on time. The commander of the 25th Infantry Brigade, Brigadier William Ramsden, contacted the headquarters of the 2nd Division, who gave orders for the column to assist the extrication of the 1st Battalion of the Queen's Own Cameron Highlanders from Violaines just to the northwest of La Bassée, their commanding officer stating that "the sight of the tanks in itself would hearten the men." The predicament of the 1st Camerons had arisen as a consequence of the German attack on La Bassée, which had swung around

Overturned early second production batch tank of the composite 4th/7th Battalion at Pont-à-Marcq, this likely being the tank that was upended by a bomb blast after leaving the Bois de Flines on 26th May. The belly plate of the Infantry Tank Mk. I was not flat, it incorporating a longitudinal upward incline on each side to impart structural strength. (Private Collection)



Violaines in order to hit La Bassée from the east. The composite battalion moved off later that afternoon, heading southeastwards down the road from Neuve Chapelle in line ahead formation, with the tanks travelling at spaced intervals. They were led through blocked villages and shellfire by dispatch rider Lance-Corporal Harold Snowden, before deploying to the right and left just before reaching Violaines. During the ensuing counter-attack the Infantry Tank Mk. I of section leader Captain Patrick Ward managed to knock out two enemy armoured cars while sustaining seven shell hits from enemy medium tanks and anti-tank guns. One of these hits penetrated the final drive housing on one side of his tank, the loss of oil forcing Ward to retire. A similar fate befell the Mk. I tank of Trooper Frederick Edge of 7 RTR, this also suffering many direct hits and a smashed final drive housing. As for the remaining tanks, George Parkes recorded that:

> Considerable artillery fire was encountered, including some incendiary shells, and also fire from enemy medium tanks firing from hull-down positions. Several of our tanks caught fire, and several sustained damage to tracks and suspension from gun fire.

Of the ten tanks that attacked, only two managed to rally at Pont du Hem, which was back up the road past Neuve Chapelle, these belonging to Captain Ward and Trooper Edge. However, unbeknown to Parkes another Infantry Tank Mk. I had managed to extricate itself by an alternative route, the debacle causing him to ponder that:

> It is probable that some tanks were showing the effect of the continual strain to which they had been subjected during the previous ten days without any real opportunity for maintenance and repair. The strain on personnel was no less severe — at the time of this attack crews had had little or no sleep for two nights, and little food. There had been no time for reconnaissance and preparation for this attack, and only one 1/50000 map was available for the whole unit.

Reserve Infantry Tank Mk. I captured at the Advanced Ordnance Depot at Arras. Visible are the shipping instructions to No. 1 Base Ordnance Depot at Nantes, just behind the bolted holes for the mine plough vertical guide plate supports. This tank is notable in that the stand for the driver's rearview mirror is fitted on the nearside for use on French roads. Only up to half a dozen of the approximately fourteen tanks at the AOD were evacuated by the British, with a couple breaking down soon afterwards. (Private Collection)

It was also the case that the attack had been mounted subsequent to the withdrawal of the 1st Camerons, and so had not provided them with any assistance. As it became clear that no more tanks were going to rally at Pont du Hem, Parkes returned to the headquarters of 2nd Division, where he was told to withdraw north across the Lys at either Estaires or Sailly-sur-la-Lys before the bridges at those locations were blown. He was then to rally with his two remaining tanks at Neuf-Berquin, northwest of Estaires, where the headquarters of the 2nd Division and 25th Infantry Brigade were also to be established. The second-in-command, Kenneth Harris, was moreover instructed to collect the LAD from Fauquissart, just east of Pont du Hem, and bring them along to Neuf-Berquin. Parkes made a final search for any outstanding tank crewmen, but this was stymied by the fact that enemy incursions had already cut the road to Violaines. On returning, he recalled that:

> The tanks and L.A.D. were overtaken at LAVENTIE and seen safely over the crossing at SAILLY which together with that at ESTAIRES, was being heavily bombed, and shelled. The staff car in which the O.C. was travelling had great difficulty in getting through, and it was dark when NEUF BERQUIN was reached.

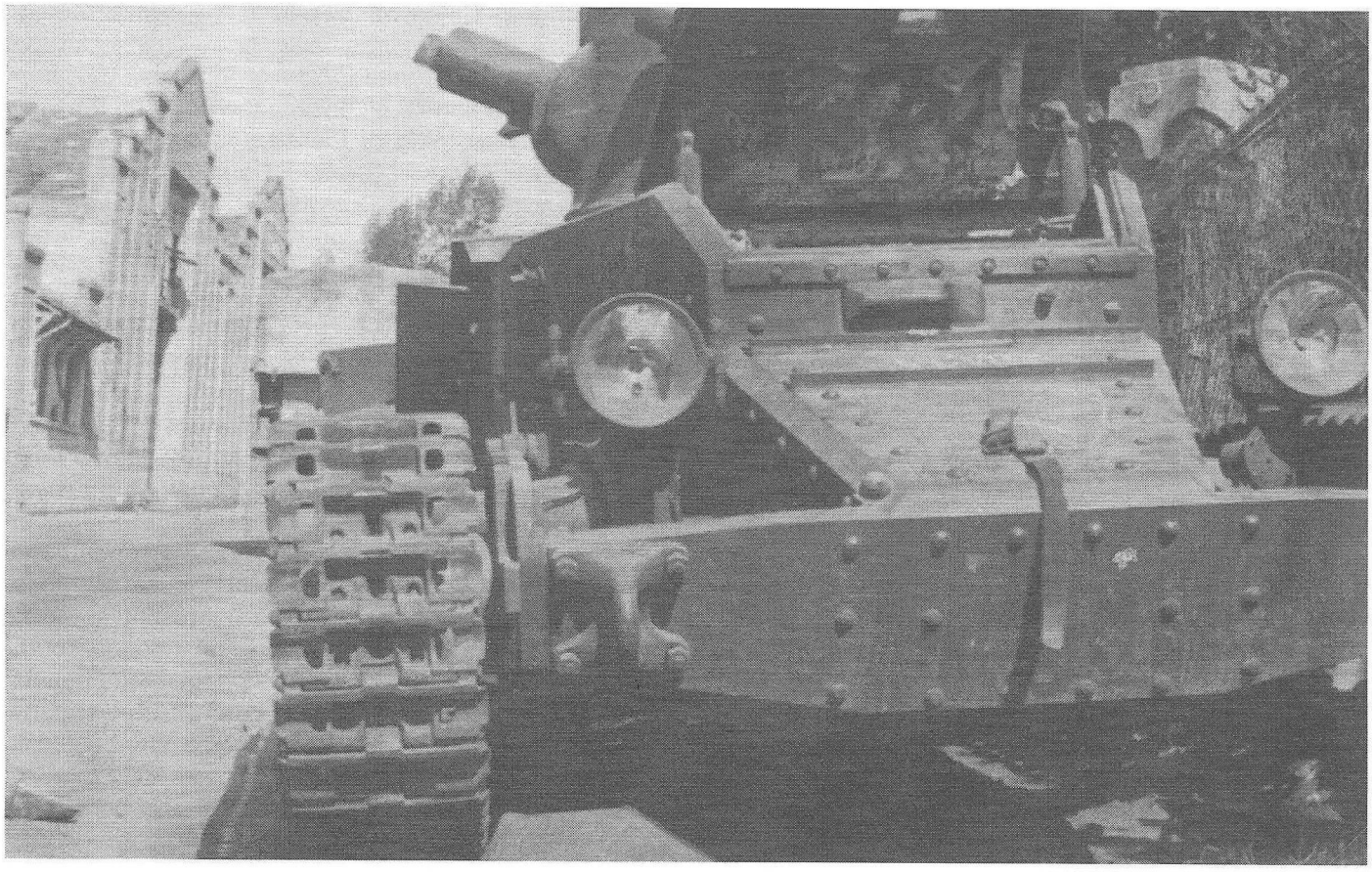
Neuf-Berquin turned out to be under shellfire, and occupied by the transport elements of a number of units, although neither the brigade nor divisional headquarters were there. The LAD and the pair of Infantry tanks had also not shown up, so Parkes and his staff decided to turn in for some rest. In fact, the LAD, having also not found any headquarters at Neuf-Berquin, had moved on to Bailleul, another eight miles (13km) to the northeast, while the tanks only managed to arrive at Neuf-Berquin at a late hour due to having taken the wrong route. They had picked up a surviving crew from a burning tank and had passed through the village in the hope that Parkes' headquarters group might be found further along the road. As the remaining pair of tanks and the LAD had apparently still not arrived by the following morning, 28th May, Parkes made an extensive but futile search of Estaires and Sally-sur-la-Lys for them. He then decided to investigate Bailleul, from where he found that considerable transport was still moving north. He managed to find the headquarters of an artillery brigade just north of the town, who informed him that a general withdrawal was being made to the coast, and so he decided to move on to Dunkirk and contact the headquarters of the 1st Army Tank Brigade. On arriving at Dunkirk after numerous obstructions, he discovered that the brigade headquarters had already departed for England. The Brigade had in fact reached Dunkirk in good order by the evening of 26th May, its account of this period lamenting that "If only some tanks had been available, it was fit and ready to fight." It nonetheless embarked and sailed to Dover on 27th May, the first full day of the evacuation, having abandoned and immobilised all of its vehicles and equipment at Dunkirk, although a number of personnel casualties were suffered from shelling and enemy air attacks on their ships. Parkes was instructed to proceed to the beach for embarkation with his staff of four, where he met up with Jock Holden during the evening, the latter not having seen the errant tanks and LAD. This party would then embark for departure from France in the early hours of the following morning, 29th May.

The LAD had reached Dunkirk and embarked on the afternoon of the 28th May, as had two dismounted crews, who had hitched lifts on the trucks of other units. The two Infantry Tank Mk. I's of Captain Ward and Trooper Edge reached Dunkirk on 29th May after constant nursing, their crews departing on that date. The third tank that had escaped from Violaines also arrived the same day, this belonging to William Armit, the vibration generated by the cobbled streets of Dunkirk precipitating its turret to split in two. The fissure in question was along a line connecting eight shell hits that the turret had sustained at Arras. The five infantry tanks (two Mk. II's and three Mk. I's) that had joined the 5th Division had become mechanical casualties, as had the vehicles of the supply detail, their crews having then joined the exodus to Dunkirk. Of these, the "mechanically doubtful" Infantry Tank Mk. II had been nursed by driver Albert Hamilton for 150 miles (250 km) before its remaining (offside) engine failed during its final action. During the early hours of 27th May Major Shields had set off to Dunkirk to make arrangements for the brigade workshop's evacuation, but having found the town deserted, he returned to Bergues. On approaching Bergues he had been intercepted by the Town Major (the British Army authority in charge of the town). The Major was worried about the possibility of a potential German tank attack, and so Shields offered him three disabled but nonetheless armed tanks in order to bolster the meagre defences at each of the town's three gates. Of the three tanks currently at Bergues, only one was suitable for defensive purposes, with the guards at Bergues being authorised to take over a further two tanks as soon as they arrived from Kemmel. There were in fact three tanks (a Mk. I and two Mk. II's) due in from Kemmel, with one of the Mk. II's being earmarked by Shields to defend the entrance to Dunkirk. The main body of the workshop then proceeded to Dunkirk for evacuation, initially by road and then on foot, these departing on the SS *King Orry* at 0800 hours, after having sustained a small number of casualties from aerial bombing. A small portion of the workshop had departed earlier on another ship, although these were to suffer severe casualties from aerial attack.

This would not be the end of the story of the Infantry tanks in the Battle of France, as the 1st Armoured Division had landed at Cherbourg, and from 26th May had assisted the French in their desperate attempts to break through the German corridor on the Somme from the south in the area between Abbeville and Saint-Valery, and thus restore the Allied lines of communication. This initiative had suffered from the same lack of planning and coordination that had thus far typified Allied armoured operations, with the consequence that the 1st Armoured Division had been obliged to retire with heavy losses. Meanwhile in the early hours of 27th May a draft of four officers and nineteen men from the Royal Armoured Corps had arrived at the headquarters of the Lines of Communications' Northern District at Rouen. These were led by Lieutenant P.W.C. Colan, their purpose being to form the nucleus of a tank company that was to join an extemporised division led by the former commander of the Northern District, Brigadier Archibald Beauman. The Lines of Communication organisation had the role of facilitating the supply and maintenance of the units in the forward areas from the ports and depots in the rear maintenance areas. The Beauman Division was to be an agglomeration of the improvised formations that had previously been amassed by Archibald Beauman, these being known as Beauforce, Vicforce and Digforce. The Beauman Division would form part of a holding force under the new commander of the Lines of Communication, Lieutenant-General Sir Henry Karslake. Its three infantry brigades, regiment of anti-tank guns and battery of field artillery were detailed to hold a 55 mile (90 km) line from the River Andelle, a tributary of the Seine, to the coast. It was the intention of the British to crêate a 2nd BEF under Lieutenant-General Alan Brooke to continue the Battle of France, although it was recognised that only a small fighting force could be dispatched to France in the immediate future.

The tanks that Colan's company were to be equipped with were originally intended to be replacements for the 1st Army Tank Brigade, although on the commencement of the evacuation of the BEF, Raymond Briggs, who was still acting as Vyvyan Pope's GSO I within the AFV Branch at GHQ, had arranged for them to be forwarded to Rouen. Later in the morning of 27th May Colan led a party to the Rive Gauche station in Rouen to pick up five Infantry Tank Mk. II's, while the remainder of the unit reported to No. 1 Base Ordnance Workshop, to which the company had been attached for accommodation and rations, prior to moving out to Camp 13 in the Forêt de Rouvray, just to the south of Rouen. The following day Colan's party conducted preliminary maintenance on their tanks at Rive Gauche station, adjusting clutches, discharging batteries, and cleaning out fuel tanks. The tanks were then taken to Camp 13, with four tanks being driven and one being towed. On 29th May Colan was raised to the rank of Acting Captain, with five Infantry Tank Mk. I's arriving for the unit at Martainville station at Rouen during the afternoon, these being taken back to the Forêt de Rouvray in the early morning of the subsequent day. It was also on 30th May that the Tank Company were joined by an RAOC Light Aid Detachment of 22 men led by Lieutenant Smith, while another three RAC officers and 23 men joined the company itself. Over the next few days the unit picked up vehicles, equipment and stores from No. 2 Base Ordnance Depot at Le Havre, and accepted a handful of additional personnel. By 3rd June all ten of their tanks were in running order and they had commenced driver training, while on this date they received their final Mk. II Infantry tank, which became their Company Headquarters machine. On 5th June the Germans used their bridgeheads over the Somme to launch the next phase of their operations, this being *Fall Rot* (Case Red), the full conquest of France. This would involve Heeresgruppe B thrusting south to envelop Paris, while Heeresgruppe A headed south-east to capture the French forces on the Maginot Line that protected France's eastern border with Germany. On this day Colan's company received a telephone call from the Northern District headquarters before dawn warning them to stand by in case of enemy parachute landings, although Camp 13 would shortly afterwards be subjected to fifty minutes of dive bombing, albeit to little effect.

Over the next couple of days Lieutenant Smith of the LAD would express doubts about the fitness of the tanks for action, with a single Mk. I and three of the Mk. II tanks having broken down in Rouen. During the evening of 7th June Captain Colan reported to the headquarters of the Beauman Division, where he was instructed to relocate nine miles (15 km) north-east to a wood at Gratianville, just east of Rouen, and await orders. The Tank Company duly moved off at 2130 hours, arriving at their destination in the early hours of the following morning, 8th June, with four Mk. I and three Mk. II tanks, three trucks, a staff car and a single dispatch rider. A single Mk. I and three Mk. II's tanks had broken down during the journey in Rouen, preventing them from crossing the Seine, and so Lieutenant Smith had taken the LAD with him to assist in their repair. Also on the morning of 8th June, the headquarters of the 3rd Armoured Brigade at Bois-Héroult, twenty miles (30 km) northeast of Rouen, was visited by Raymond Briggs, who informed the brigade commander, Brigadier John Crocker, that Colan's small force of Infantry tanks was to come under his command. The 3rd Armoured Brigade was one of the two main sub-formations of the 1st Armoured Division, the other being the 2nd Armoured Brigade under Brigadier Richard McCreery. Both of these brigades had retreated south from the Somme to the area east of Rouen,



Front view of another tank captured at the Advanced Ordnance Depot. This gives a detailed view of the splash guard along the top of the driver's visor plate and the hydraulic telescopic struts for opening the hatch. Each strut incorporated a cranked handwheel for raising and lowering both the struts themselves and the driver's seat. On the nose plate can be seen the securing strap for the towing hawser. (Private Collection)

their task now being to assist the Beauman Division in the defence of the Andelle. Later in the morning Captain Dow from the Beauman Division brought Colan a message from Raymond Briggs, this ordering the Tank Company to assist the infantry in covering the crossings over the Andelle at Vascœuil, a couple of miles east of Gratianville. As such, they would also be covering the 3rd Armoured Brigade's southern flank close to Croisy-sur-Andelle.

Gratianville happened to be the location of an A10 Cruiser tank of the 3rd Armoured Brigade that had broken down the day before. As this tank had a No. 9 Wireless Set tuned to the brigade net, and as it had been restored to mobility (albeit with steering issues), it was added to Colan's force as the Rear Link. This made up for the loss through mechanical breakdown of the company headquarters' tank at Rouen, a scout car was also being donated to the Tank Company. However, as no further mention of the A10 was made in the company's diary, it appears to have been quickly discarded. In response to his orders Colan dispatched a pair of Mk. I and a pair of Mk. II tanks to Vascœuil, these being divided equally between the northern and southern bridgeheads, the remainder of the force remaining at Gratianville where the Mk. II tanks tested their 2 pounder guns. Meanwhile at Rouen, Lieutenant Smith had held a meeting with the men of his LAD, this resulting in the decision of the RAOC men to abandon the repair of the four crocked tanks, and to evacuate themselves to Nantes. What had prompted this decision, beyond mere self-preservation, was not revealed, although 2nd Lieutenant Godfrey of the Tank Company attempted to continue the salvage operations. Thanks to his efforts two of the Infantry Tank Mk. II's were entrained at Sotteville station, near Rouen, these presumably being destined for Nantes. The third Mk. II was abandoned in the station yard, while the single Infantry Tank Mk. I was abandoned on a street in Rouen, with the 2 pounder guns and Vickers machine guns of all four tanks having been disabled and the wireless set removed from the Mk. I. In the meantime at 1100 hours the 3rd Armoured Brigade had been ordered to withdraw from the Andelle by the 1st Armoured Division headquarters, despite them having seen little evidence of enemy activity. The 'B' Squadron of the Queen's Bays, who were under the command of the 3rd Armoured Brigade, confirmed that all but one of the bridges in their sector

had been blown, and that the infantry of Beauforce were starting to depart. A short while later, the Germans attacked the Andelle line in force in a number of locations, with the Bays reporting coming under shellfire. 2 RTR, of the 3rd Armoured Brigade, also reported the arrival of enemy tanks, and by midday the units of 3rd Armoured Brigade were actively engaging the enemy.

The infantry holding Vascœuil were ordered to prepare to withdraw at 1300 hours, leaving the bridges intact, with Colan's company being requested to cover their withdrawal. The small force were to fall back south to Les Andelys, on the north bank of the Seine, from where they would cross the river and rendezvous at Saint-Julien-de-la-Liègue, the entire journey comprising 27 miles (43 km). At 1500 hours John Crocker ordered a general withdrawal south of the Seine, with the force at Vascœuil commencing their departure two hours later. They initially moved five miles (8 km) directly south to Fleury-sur-Andelle, although on reaching Les Andelys they found the town in flames, with the bridge there having been closed by the French. They therefore diverted through Courcelles-sur-Seine further south, their progress being badly hampered by refugees to the extent that they had to wait 2½ hours to cross the river. It was at this juncture that one of the Infantry Tank Mk. I's developed gearbox trouble, an issue that had also marred the withdrawal of the 1st Army Tank Brigade. They eventually arrived at Gaillon, just short of their intended destination at Saint-Julien, before dawn on 9th June. The 3rd Armoured Brigade had already made their way over the Seine the previous evening, as had the 1st Armoured Division headquarters. Meanwhile Rouen had been evacuated of Allied troops, such that Erwin Rommel's arriving 7. Panzer-Division would find it practically deserted. The last elements of the 3rd Armoured Brigade were departing from Gaillon just as Colan's company arrived, although they undertook to send back diesel and petrol in order to keep the Infantry tanks moving. After a severe bombing raid on Gaillon the Tank Company moved into harbour on the outskirts of the village, sending one of their trucks to Evreaux to pick up fuel and supplies. By the early afternoon they were receiving reports from the French that the enemy had crossed the Seine, this prompting the company to withdraw to a "tactical position" on the high ground to the west of Saint-Aubin-sur-Gaillon, just south of Gaillon itself. This particular spot allowed them to intercept any passing fuel supplies, while also enabling them to withdraw to Evreaux, fifteen miles (25 km) to the southwest,

Infantry Tank Mk. I range target with its engine compartment roof removed. Visible are the engine inlet manifold, the selector lever of the gearbox, and the offside steering brake and brake drum, both of which are nestled within their mounting frame. The offside fuel tank can also be seen, the engine and gearbox being neatly sandwiched between the two tanks. *(Private Collection)*

if necessary. The efficacy of such a retreat would depend on their remaining fuel supplies, and to optimise these the Mk. I tank with the defective gearbox was disabled and abandoned. This left the company with three Mk. I and three Mk. II tanks.

In the early evening Lieutenant-Colonel Leonard Diggle, the commander of the Beauman Division's 'C' Brigade (formerly Digforce), sent written orders to Captain Colan tasking him with reporting to *général de brigade* Marie Maillard, the commander of the 5e *brigade de cavalerie* (5th Cavalry Brigade). The Tank Company were to be attached to the French, with Maillard instructing Colan's force to investigate reports that four enemy tanks were in the vicinity of Venables and Villers-sur-le-Roule on the south bank of the Seine, three miles (5 km) north of Gaillon. The Tank Company duly moved northwest to Fontaine la Verte, just behind the area to be reconnoitred, their dusk arrival coinciding with that of the French cavalry and artillery. Captain Colan's Infantry Tank Mk. II developed problems with its Rackham steering clutches en route, this prompting him to switch to one of the remaining Mk. I tanks. The Tank Company would report that "Reconnaissance was limited owing to lack of petrol, supplies not having arrived. There was no sign of enemy tanks." Nevertheless they agreed to a French request to mount overnight standing patrols in the vicinity, these being broken off in the early hours of 10th June so that they could refuel with petrol that had been ordered for them by the French. A further request from their French liaison officer to search the woods to the northwest of Gaillon for infiltrating Germans also yielded no result, it being noted that the "Ground [was] very difficult for tanks". At 1000 hours on 10th June, Maillard ordered Colan to once again probe Villers-sur-le-Roule, albeit this time with artillery support. This proved abortive due to an incorrectly marked map which took the company beyond the village and in sight of the Seine. An "impassable ditch" prevented the tanks from doubling back on to the correct route, despite numerous attempts, although Colan could at least report that no enemy had been encountered.

The company were then ordered to make another attempt to reach Villers-sur-le-Roule via Venables, which they were informed was still in French hands. However, before the advance to Venables could commence, the Infantry Tank Mk. I commanded by 2nd Lieutenant Rickwood suffered an engine seizure. The three remaining fit tanks set off at 1300 hours, these being led by Company Sergeant Major Hair in the single Mk. II, followed by the Mk. I's of Captain Colan and then Sergeant Locke. This move would quickly reveal that the Germans had now crossed the Seine, the Tank Company's diary recollecting that:

> Approaching VENABLES the column came under A/T and M.G. fire, from woods on Left and Right flanks of village. C.S.M. HAIR engaged the (heavier) fire from the Left flank whilst Capt. COLAN, followed by Sgt. LOCKE, moved on towards the village opening fire on the Right flank.

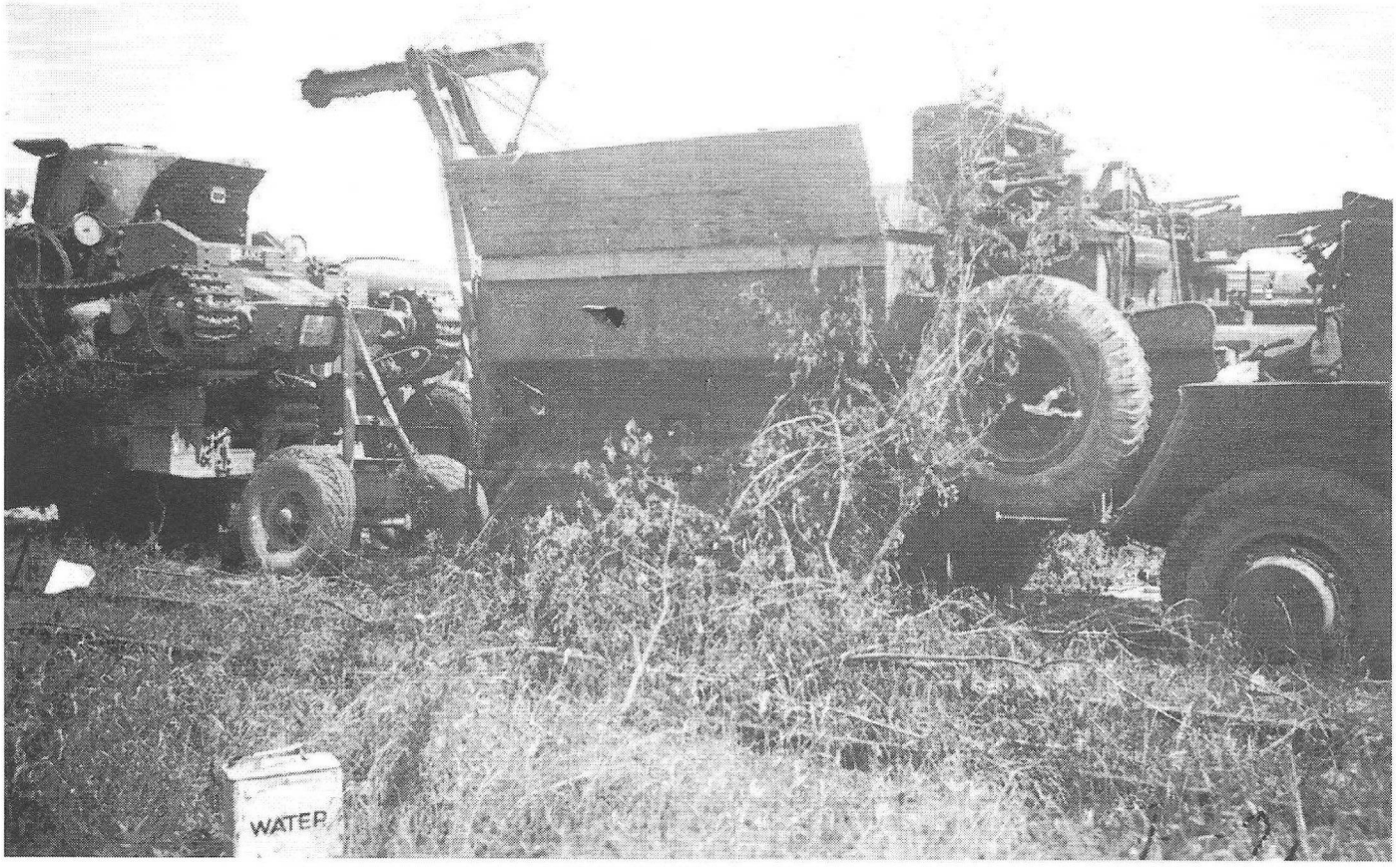
The anti-tank fire would have been of relatively light calibre, with the armour of the A11 once more proving efficacious, as:

> Capt. COLAN's tank received a direct A/T hit on the turret from the Left flank, but no damage was done. He engaged the Left flank and swung round to Left to get under cover where the road ran through a shallow cutting, but was hit on the track before reaching cover. The tank was abandoned under covering fire from the other tanks. Intensive fire by Sgt. LOCKE resulted in the slackening and final cessation of enemy fire. The derelict tank was then blown up by C.S.M. HAIR, who put 2 2pdr rounds into the engine compartment at 150 yards [~150 m] range.

The chances of recovering the tank had of course been much reduced by the departure of the LAD, whose absence doomed any defective vehicle. The company's diary summarised that:

> Throughout the action the enemy was very well concealed, only one man being seen. The 2 remaining tanks then withdrew, coming under M.G. fire again after moving ½ mile [~1 km]. A total of 15 2pdr and 1500 ·303" rounds were fired by the three tanks during the whole action.

Shortly after the company's withdrawal, their French liaison officer arrived in a staff car, belatedly informing them that Venables was in enemy hands. The retirement of the French necessitated the abandonment of 2nd Lieutenant Rickwood's Mk. I tank, with the liaison officer being tasked with destroying it with an anti-tank gun at his convenience. Captain Colan then reported to General Maillard and Lieutenant-Colonel Diggle, informing them that the Venables position was only lightly occupied and did not necessitate a general withdrawal. Maillard responded that as the Germans had crossed the Seine at Vernon, he was pulling back in order to avoid being cut off. He then ordered Colan to cover the withdrawal of his headquarters to the south. Colan returned to the rest of his company, who were now at Vieux-Villez, midway between Gaillon and Ailly, where he was informed that the enemy were only a kilometre (half a mile) distant. He then led his two reserve Mk. II tanks and wheeled transport to rendezvous with the French headquarters,



Infantry Tank Mk. I Drake *of 4 RTR being carried on a 7½ ton light recovery trailer towed by a six ton AEC 850 FWD tractor, which almost certainly belonged to one of the three recovery sections of No. 2 Army Field Workshop. These sections combed the road between Enghien and Tournai following the retirement of 1st Corps from Belgium, with No. 5 Recovery Section discovering three abandoned infantry tanks on 18th May and disabling them* in situ. *No. 6 Recovery Section picked up an infantry tank on 19th May and retired with it to Merckem near Ypres.* *(Robert Gregory Collection)*

although one of the Mk. II tanks suffered a track breaking in two places, and so was abandoned after being set of fire with 2 pounder fire from the other tank. On reaching La Croix-Saint-Leufroy, which was on the banks of the River Eure six miles (10 km) southwest of Gaillon, Colan met 2nd Lieutenant Rickwood, who was commanding the third Mk. II tank and the remaining Mk. I. Rickwood told him to proceed to Irreville, another 2½ miles (4 km) to the southwest, which they reached at around 1800 hours in the evening. Here the Mk. II tanks were refuelled by a French anti-aircraft unit, although the French headquarters was still nowhere to be seen. The steering clutches of the last Infantry Tank Mk. I collapsed, however, and the vehicle burst into flames, this marking the end of the service of the A11 with the Beauman Division Tank Company.

Colan's unit, with their two remaining Infantry Tank Mk. II's, pushed on to the southwest in the general direction of Sées, which was about 70 miles (110 km) away, passing through Évreux and Conches-en-Ouche. However one of the Mk. II's broke a track in the Forêt de Conches, four miles (6 km) to the southwest of Conches itself, prompting the column to harbour in the woods. The unit halted in this location for a couple of days and came back under the control of the Beauman Division, while errands were made in order to source spare track pins. As this was unsuccessful, the company progressed 25 miles (40 km) west to La Chapelle-Gauthier on 12th June by the ploy of sending one tank ahead and then sending back its track pins so that the other tank could follow. An abortive attempt was then made to salvage an A13 Cruiser tank in order to augment the company, but this effort failed, as did an effort to secure a spare A13 from among the tanks being evacuated by the 1st Armoured Division. Elsewhere the ever more apparent crumbling of the Allied front would prompt *général* Weygand to appeal to the French Government to start negotiations with the Germans for an armistice, while Alan Brooke belatedly arrived in France to take command of what currently passed for the 2nd BEF. Brooke met Weygand during the morning of 14th June, and was informed that the organised resistance of the French Army had effectively come to an end. By this time the Germans were entering Paris and the French Government had moved to Bordeaux, and Brooke was presented with a plan for the remaining British forces in France to join a "redoubt" in Brittany, where ongoing

resistance could be supplied by sea from England. He was sufficiently alarmed by these developments to contact London and urge both the CIGS, Sir John Dill, and the Prime Minister to consider the withdrawal of British forces.

Meanwhile on 14th June, Colan's company were tasked with protecting the Beauman Division's headquarters at La Goulafrière, three miles (5 km) south of La Chapelle-Gauthier. As only one of the Mk. II tanks was capable of movement, the decision was taken to modify their Austin staff car and a 15 cwt. truck into armoured cars by using earth-filled fuel tanks and corrugated iron sheeting, these being armed with Vickers and Lewis machine guns. The new armoured car section was commanded by 2nd Lieutenant Rickwood, and augmented the pair of Infantry Tank Mk. II's in covering the approaches to the divisional headquarters. During the evening a message to Brooke from the Secretary of State for War, Anthony Eden, authorised him to prepare to withdraw to England. Colan's company was accordingly ordered to move on to Bonnebosq, thirty miles (50 km) to the northwest, on 15th June, the Mk. II tanks once again advancing by the method of swapping track pins, although one of them only just managed to limp to the destination after suffering a damaged radiator and subsequent fire in one of its engines. The company then moved off to Ranville, twenty miles (30 km) to the west, the following day with the two tanks being entrained at the station at Caen, presumably for Cherbourg, the defective Mk. II being assisted by a tow from a six ton truck. The company followed the Beaman Division's headquarters to Cherbourg on 17th June for evacuation with the division, embarking on the SS *Blair Nevis* that evening, although Colan and his driver embarked on the SS *Tynwald*. Thus ended the short life of the Beauman Division Tank Company, the only notable aspect of their service being that the Infantry Tank Mk. II's in their employ gave somewhat better mechanical performance than the Mk. I's, although both models were in the hands of relatively inexperienced crews. The official tally of Infantry tanks lost in France was 97 Infantry Tank Mk. I's and 29 Infantry Tank Mk. II's. The total of Mk. I's lost comprised the 77 with the 1st Army Tank Brigade, the fourteen unarmed machines at the Advanced Ordnance Depot at Arras,

Infantry Tank Mk. I's being collated with other Allied types at the railway yard at Arras, their turrets marked with German recovery numbers and captured symbols. Also visible are various Renaults, Hotchkisses, Somuas and an Infantry Tank Mk. II. (Robert Gregory Collection)

the five with Colan's force, and one unaccounted for. The total of Mk. II's consisted of the 23 with 7 RTR and the six with Captain Colan. No Infantry tanks returned from the Continent, leaving 42 Infantry Tank Mk. I's available for service in England. German records indicate that by 15th October 49 knocked out or abandoned Infantry Tank Mk. I's had been officially recorded, with thirty of these having been recovered and sent away.

After returning to Aldershot 4 RTR would be re-equipped with Infantry Tank Mk. II's, while 7 RTR at nearby Tweseldiown would receive a mixture of Infantry Tank Mk. II's and III's, with 8 RTR retaining the same mix as had 7 RTR, having 27 Mk. I's and 23 Mk. II's. Following the end of the debacle in France, a profusion of reports were produced that recapitulated and analysed the events. The one that drew most directly from personal experience was that of Robert Cracroft, who appended a number of points of interest to his narrative of the Battle of Arras, which was written on 9th July. He deprecated the installation of the 0.5 in. (12.7 mm) Vickers Machine Gun, relating that "Stoppages were difficult to rectify" and that "Personnel questioned in tanks equipped with ·5 are unanimous that they that they would prefer ·303." On the other hand, he recognised "The great advantage of tracer ammunition", as "This was used in the proportion of 3 in 1 and proved invaluable." Cracroft drew attention to the "large number of enemy anti-tank guns encountered" and "The vulnerability of the crews of these anti-tank guns." He maintained that "A burst of well directed ·303 M.G. fire at the flash invariably silenced the guns even up to ranges of 800 yards [~800 m]." What was notable about this comment is the absence of what would become a common complaint in the desert, which was the lack of a high explosive shell to deal with anti-tank guns. He further observed that "Anti-tank guns were always sited frontally. In no case was an anti-tank gun seen in a defiladed position. The guns were usually well concealed but were clearly indicated by the flash of firing." This was likely due to the Germans having been surprised by the British, rather than being ascribable to a lack tactical acumen, as luring the British onto defiladed anti-tank screens would become a German speciality in the Desert. However, even when the dedicated German anti-tank gun, the 3.7-cm-Pak, achieved a strike, its small calibre rendered it ineffective, as:

> The 'I' Tank Mk. I was definitely proof against the German anti-tank gun. One tank showed as many as 14 direct hits and the only indication the crew had of being hit was a red glow for a few seconds on the inside of the armour plate.

Cracroft acknowledged "The accuracy of the German field batteries" with "targets frequently being engaged within 5 mins. of being spotted, such targets being groups of three tanks etc." He largely credited this to the German reconnaissance aircraft, although the excellent German air-to-ground communications were not quite as efficient as he imagined. It was nevertheless the case that "Although on frequent occasions tanks passed through heavy enemy H.E. concentration[s] nothing but a direct hit affected the tanks." Cracroft then noted "The poor fighting qualities of the German troops encountered", as "They were very young and large numbers were observed lying on the ground feigning dead, others ran up to the tanks surrendering." Surprisingly enough had not been an uncommon observation in France, with the 1st Armoured Division also gauging the morale of their prisoners as being "indifferent", this being ascribed to their recent drafting and consequent lack of experience. However, it would appear that the speed of the German advance and their use of combined arms did not necessarily require a particularly tenacious performance from their field troops. Cracroft further tendered that "The effectiveness of the tank advance was very noticeable. Had infantry been available in sufficient numbers and counter battery fire been available the forward position could have been maintained." In terms of the latter factor, he underlined that "No artillery support of any description materialised during the attack", while "No air support or protection from enemy bombers or recce machines of any description was given." Cracroft submitted that:

> A large percentage of losses of tanks was due to mechanical breakdown due to excessive mileage during the past ten days and lack of time for maintenance. Had the infantry been able to maintain the forward position to which they had advanced most of these tanks could have been recovered.

The proportion of breakdowns due to wear was in fact moderate for the period, with other contributing factors being the generally inadequate recovery and workshop facilities, and the lack of time to repair tanks before the battle, as well as the general policy of repairing defective units rather than replacing them. The assertion that more tanks could have been recovered if the British had held their ground was justified, as yielding territory was the main cause of permanent tank losses during the early war period. This was due to the anti-tank weapons available being generally incapable of causing catastrophic damage to their targets. Cracroft admitted the poor command and control that had dogged the British at Arras, recalling that:

> Wireless control collapsed early in the battle. This was probably due to lack of time for netting. Rear link set shorted before the start line was crossed. Control was consequently extremely difficult

and communication with Bde H.Q. non-existent. These difficulties were increased by the size of the front and the depth of the advance.

The lack of time for netting had of course been partially self-imposed by the brigade headquarters, this adding an unnecessary limitation to those already imposed by the rushed planning for the attack. Finally, both the positive and negative aspects of the battle offered Cracroft a degree of encouragement, as "Although little infantry support was available and the Bn. was not used in the role of an 'I' Tank Bn. everything that happened confirmed the correctness of our previous training and doctrine in 'I' Tank tactics." 7 RTR opined on their tanks soon after returning to England, compiling their *Report on Mechanical Efficiency of I Tanks Marks I and II* on 30th May. Concerning the Mk. I, the verdict was that:

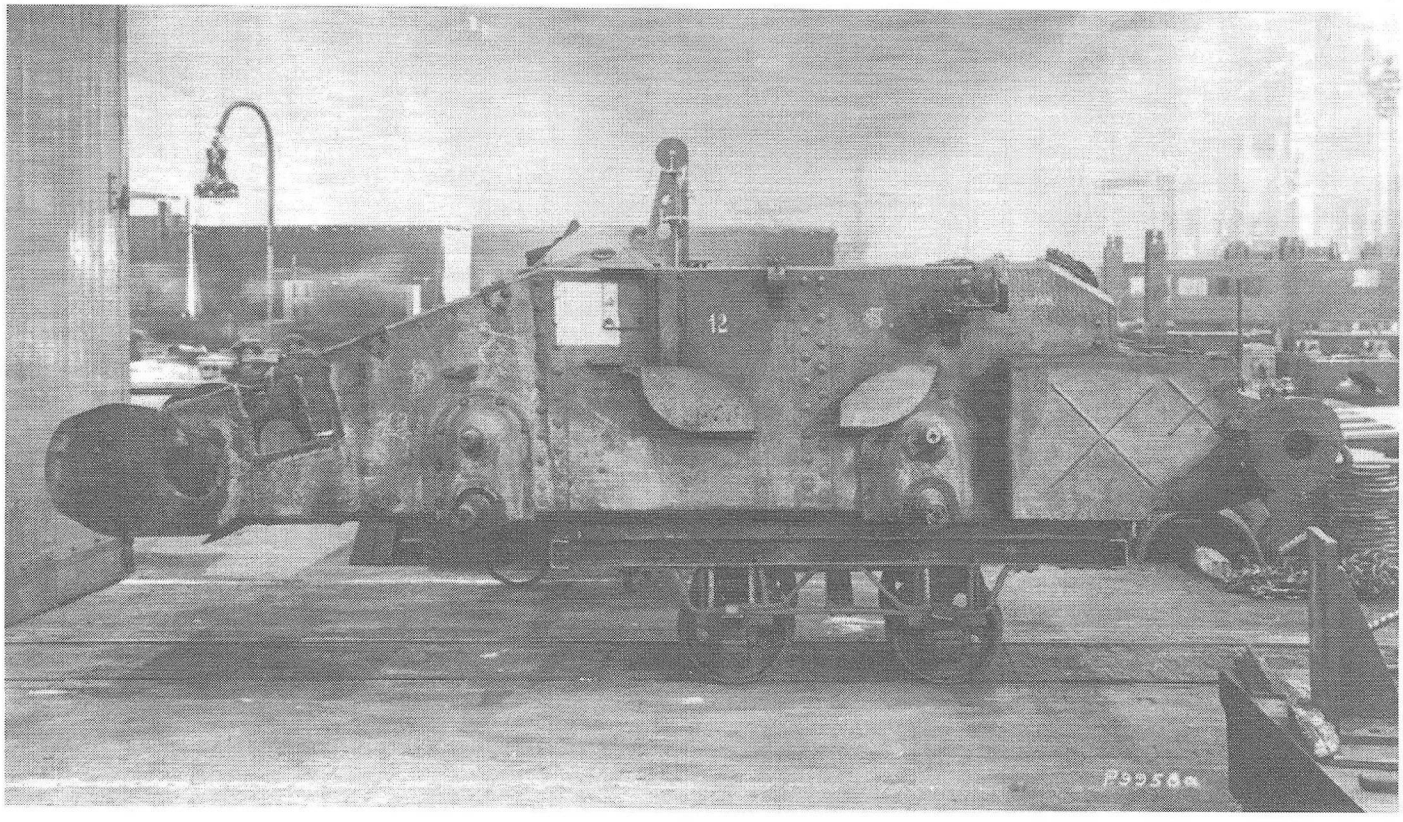
> On the whole this type of tank was very satisfactory. The tracks appeared vulnerable, but stood up admirably to road work, which consisted of 300 miles [500 km] approximately. There were only few cases of tracks being damaged by fire. The weight of the tank is eleven tons, and it is apparent that the engine is not powerful enough to compete with this weight. However it is easily maintained, and repairs can be executed fairly quickly.

Unsurprisingly, the only component that drew any ire was the gear selector lever on top of the gearbox, it being detailed that "The outstanding defect was that the gear actuating shaft and selector fork snapped easily and frequently, and even with the large number of spares carried it was found to be impossible to keep in action a full compliment of Tanks." It was further elucidated that:

> The reason for this defect appears to be that the control from the gear lever to the bucket takes the form of a long rod to the actuating shaft, which is at right angles to the rod. This places a heavy strain on the shaft. The gear selector fork is of cast metal, and is attached to the actuating shaft, and on account of the heavy strain snaps very easily.

The three horizontal actuating shafts (known as selector rods) which held the selector forks were located directly below the gear lever on the top of the gearbox, the shafts being actuated by a finger that formed the bottom tip of the lever which engaged an

Stripped down hull of 4 RTR tank Derwent *in a German workshop, showing the arrangement of the bogie mountings and the stowage brackets for the towing hawser. Midway between these brackets is the upper clamp for the hawser, which was fastened with a wing nut. Also notable are the flanges for the track adjuster and the final drive housing. A section of the rear hull has been cut away on both sides, possibly for subsequent armour testing.* (The Tank Museum)



indentation (or "bucket") in the top of the selector forks. The Infantry Tank Mk. II generated more complaint than the Mk. I, this reflecting its more complicated nature, with the whole powertrain coming under scrutiny. Nonetheless, the view was that "on the whole the Tank was quite good, but a more powerful engine and a different type of gear box are absolutely essential." On 17th June Douglas Pratt wrote a letter to Percy Hobart giving his initial account of the campaign in France, exclaiming that "We had a very busy fortnight of war & we covered by road (including the Matilda Is) some 300 miles [500 km]! 160 miles [260 km] in 5 days, 200 [300 km] in 7 days was roughly our reckoning." Regarding his limited establishment, he recounted that "I had 100 tanks at the start, of them 77 were Matildas [*i.e.* Mk. I's], & only 23 that were really able to hurt the Bosch & had the 2 pr." Pratt was rightly scathing of the Dyle Plan, fulminating that:

> With great *élan* we railed them all up to near Brussels, in that ghastly plan, which I feel was the foundation of all our troubles! Why we had to leave the frontier line on which months of work had been spent & then go and sit on the Dyle with only 48 hours to dig in was quite incredible — over loyalty to our allies I fear.

The Dyle Plan had been the root cause of the disaster that had beset the Allied armies in France, and if the French high command had actively wanted to collaborate with the German offensive, they could hardly have conceived of a better means to do so. It offered both the strongest French forces and the BEF to the Wehrmacht on a plate, as it dovetailed with the plan for *Fall Gelb* almost perfectly. The Germans had hoped to lure the Allies into a trap, being unaware that the Allies had already planned to leap into it eagerly. Once the Allies had entered Belgium *en masse*, they inevitably became hostages to events, as Pratt bitterly remembered:

> Then came the withdrawal from B[russels]. We wanted our [railway] trucks, but they could not be found by Movement Control, & even if they had been forthcoming I doubt if we could have entrained on account of the bombing. All important & even many small stations had been heavily bombed.

This once again indicated that the British had made the assumption that all their long distance tank movements could be undertaken by rail, as they had been during the previous war. Unfortunately the combination of concentrated aerial attack and fast mobile ground warfare had made this method sufficiently hazardous that it could no longer be exclusively relied on. The alternative was not always better in the circumstances, as "All moves were difficult on account of blocked roads, full of refugees and bombing." Pratt gave Hobart a brief summary of the Battle of Arras, which was not flattering of his superiors, as he reprised that:

> I was then working with Franklin [*sic*] & Martel was with him too. With the greatest difficulty I managed to postpone the attack on the 21st until 2 p.m. F. wanted it about 5 a.m., but I told him the crews must have some rest & do maintenance & we must reconnoitre.

As we have seen, 7 RTR believed that Martel had already conceived a dawn attack even before Franklyn had arrived, although there is no direct evidence that either of these men had pressed for this. However, Pratt expressed his dismay at the plan that was eventually conceived, as:

> The start line was nearly 8 miles [13 km] distant from Vimy, then 1st obj[ective] was 6½ miles [10.5 km], & 2nd obj. another 3 miles [5 km] to Sensée R. I told them I was given an Armd Div role with slow tanks & no protective reconnaissance, but this availed nothing. The whole show was one mad rush in spite of all protests.

The refusal to countenance any kind of reconnaissance had been a particular grievance for Pratt, and one which was well justified. The apparent inactivity of the other arms was also stressed, as:

> Infantry were nearly an hour late, artillery support none ever fired a round, & the air support promised never materialised. In fact it came to 4th and 7th on two centre lines battling their way forward. This they did but of course with no support of any kind it was out of the question to advance 10 miles [16 km]! We got about 4 miles [6 km] forward before any infantry of ours appeared in sight.

However it should be remembered that the infantry had directed their own accusations at the 1st Army Tank Brigade, especially 8 DLI, who considered that 7 RTR had left them in the lurch. Pratt was keen to highlight his brigade's early success, as:

> During this time we played hell with a lot of Bosch M.T. & thin skinned stuff. Tracer ammn. put a lot up in flames. His a/t gunners after firing a bit bolted & left their guns even when fired on at ranges of 600 to 800x [*i.e.* yards (~600–800 m)] with m.gs from

> Matildas. Some surrendered, & others feigned dead on the ground!

The resilience of the Infantry tanks was also extolled, as:

> None of his a/t stuff penetrated our Is & IIs & nor even did his field artillery which fired H.E. Some tracks were broken & a few tanks were put on fire by his tracer bullets, chiefly in the engine compartment of the Matilda Is.

Pratt in this instance had failed to concede how effective the artillery had in fact been in breaking up his brigade's attack, even if it hadn't destroyed any tank directly. This omission was carried over to his next comment, which upheld that:

> The main opposition came from his field guns, some of which fired over open sights also the air dive bombing of the infantry. This of course did not worry the tanks much. One or two bombs bursting alongside a Matilda turned one over & killed the Comdr; another lifted a light tank about 15' [5 m] in the air!

The generally good fighting qualities of the Infantry tanks had been confirmed in the extenuating circumstances, as "The whole show was appallingly handled by 'the powers that be', but we did learn that our tank armour is good at present, & that our 2 pr is quite sufficient also for the present." Regarding the inadequacies of the planning and preparation, Pratt urged that "Had we only been allowed to stage a methodical battle with a series of reasonably short objectives with some arty support & even a little air support & no frantic rush, we should have done far better & saved many lives of fellows we cannot afford to lose." Ordinarily this assertion would have been true, but in the event, if the attack had been delayed then the Germans were likely to have attacked first, and the element of surprise that had so benefited the British advance would have been diminished. Arras was a rare example of a badly planned and executed operation gaining outsize benefits due to the psychological effect it had on the enemy, and despite the fact that almost everything had gone wrong the attack could be considered an overall success. This was however more due to the response invoked on the German side than the effort exerted by the British themselves. Of the lessons that could be extracted from the operations on the Continent, Platt submitted that "No reliance can be placed on moves by Rail. All tanks must be capable of moving 40 to 50 miles [65–80 km] a day 5 days in the week." This was a prescient statement as British tank development would increasingly be focused on improving mechanical durability, to the extent that when the Allied armies returned to the Continent, British tanks would be capable of moving uninterrupted distances far in excess of what Pratt here prescribed. Indeed the standard of automotive excellence embodied in late-war British tanks has rarely been fully appreciated. Regarding offensive firepower, Pratt reasoned that "Every tank must have at least one 2 pr, m.gs are useless alone (this of course we all knew years ago)." Again it is worth noting the absence of criticism pertaining to the lack of a high explosive round for the 2 pounder, which would be a consistent complaint in the desert. It was of course the case that the quantity of explosive that could be contained in the small 2 pounder shell would be little more than nugatory, which is why there was such reluctance on the part of the Ministry of Supply to provide a HE round in the first place. Pratt accepted that "Our armour is good enough now & so is our 2 pr with solid shot, but the Bosch has now seen both, so we must improve both." Although the Infantry Tank Mk. II was considered a superior fighting tank to the Mk. I, the reverse was the case when it came to automotive performance, as:

> Mk. II is nothing like reliable enough at present. More of our losses were due to mech. troubles, Wilson g. box and AEC engines, Rackhams, etc. No time for workshops to repair them.

As we have seen, the 1st Army Tank Brigade had somewhat erred in insisting that their Mk. II tanks march at a higher speed than the Mk. I's, whereas it would have made sense to drive them both at the same pace, thereby reducing the wear on the A12's. The reliability and durability of the Infantry Tank Mk. II would be gradually improved as progressive improvements were made to its drivetrain, the most notable being the substitution of the AEC engines with ones produced by Leyland Motors. Pratt rather unusually tendered that:

> Our tanks must be clearly marked. Many cases of our tanks shooting French tanks. French tanks shooting at us etc. Aeroplane markings with circles seem suitable. French do use this but it is hard to see even this when paint is dirty.

This suggestion would not be immediately acted upon, principally because the British would not be fighting alongside a major ally for the next three years, although the American white star would be adopted on British tanks prior to the return to France for air recognition purposes. Pratt stated that "The wireless worked intermittently" and that "At Arras there was a

breakdown due to faulty fitting, everything was rushed." This suggested that the reason for the shorting of the rear link sets was due to their having been removed for servicing when (or before) the brigade had reached Vimy on 20th May, and had then had to be urgently reinstalled in time for the attack. This may in turn have had some bearing on why the instructions for netting had insisted on this being undertaken just before crossing the start line, although the instructions themselves had not reached their intended recipients. As such, this was a fault that Pratt himself bore some responsibility for. Finally, he noted that "Tracks stood up well, except for pins", the truth of this statement being particularly borne out by the experience of Captain Colan's company. Douglas Pratt's comments on the limitations of the railways were echoed in a report compiled on 4th June by Major Rodney Shields of the 1st Army Tank Brigade Workshop. Shields insisted that "Rail transport for Infantry Tanks proved unreliable and some form of road transport means should be provided to reduce the wear and tear involved by driving tanks many miles over metalled [*i.e.* tarmac] roads." However, rather than following Pratt in calling for more mobile and durable tanks, he proffered that:

> It should be possible to devise a strong and inexpensive trailer which would be towed by a scammell tractor of simple but equally robust construction and designed for road work only. Alternately a tractor and trailer arrangement might be designed to carry two Infantry Tanks. Winches could be dispensed with for loading by the use of jacks capable of lowering a platform to the ground and raising it after loading.

This in effect was an advocacy of the mass use of tank transporters to reduce the mileage accrued by tanks over long distance moves. In the event the British would adopt the widescale use of tank transporters as a policy, although the overwhelming majority of the tractors, and a good proportion of the trailers, would be supplied by the Americans to standard designs. Shields' idea of using jacks would not be implemented, with winches being the standard method of assisting the loading of tanks. Both the adoption of tank transporters and the development of highly durable tanks were two of the key methods by which the British would ensure that their armoured units and formations could cover extensive distances, and spend long periods in the field, while maintaining their established strength. The third major method would be by holding a large number of reserve tanks in any theatre in which they were engaged, and the lack of reserves available to the BEF was symptomatic of the British Army's unpreparedness for the exigencies of armoured warfare during this early period. Indeed the absence of these factors in France was the reason that Shields could tender that "It is believed that many of the 1st. Army Tank Brigade had almost reached a condition requiring overhaul by the time they reached Arras." On the subject of recovery, Shields testified that:

> Three scammell tractors were found to be insufficient. Most recoveries took between 4 and 8 hours to complete due to the necessity of not only towing a tank from the field on to the road, but also of towing it along the road to the workshop. Tracks often had to be repaired repeatedly on route. If transport capable of carrying tanks along roads were provided as suggested ... above, then 3 scammell tractors would be sufficient because they could be used exclusively for towing tanks from the field to a road and the road transport could be used for taking them to the workshop. Otherwise it is considered that 6 scammell tractors are required.

The inadequate facilities and equipment provided for recovery was yet another instance of the lack of given to the problems of maintaining large armoured formations in the field in wartime. Recovery would be another discipline that would mature into a more complex and sophisticated activity as the war progressed, with recovery sections and companies becoming better equipped and more autonomous, and armoured units themselves becoming more responsible for the early stages of recovery. Indeed dedicated armoured recovery vehicles would eventually be allocated to units, these being based on the chassis of the gun tanks that they were already issued with. Regarding specialised equipment, Shields suggested that:

> A robust towing triangle should be provided to facilitate the towing of Infantry Tanks with defective steering clutches. When steering clutches could not be repaired, it was necessary to employ a scammell tractor in the front of the tank and another heavy vehicle in the rear to effect steering and to prevent overrunning.

Just such a triangle would be evolved by Joseph Hollebone, this becoming appropriately known as the Hollebone Drawbar, although user opinions on it were not always enthusiastic. Concerning the suitability of the recovery personnel, it was proposed that:

> The number of Driver Mechanics should be increased to 18. The Driver Mechanic is admirably suited for Recovery work. The Driver Mechanics of this unit frequently had to work for days with very short

The sad fate of A11E1, which was used by Vickers-Armstrongs to test the Blacker Bombard, an infantry anti-tank weapon that a HE projectile fired from a 29 mm spigot mortar. The date of this trial is unclear, it being undertaken some time during autumn 1940. The evaluation was a success, the Bombard cleanly penetrating the 60 mm mild steel side plate with great destructive effect, with one of the offside bogie mountings being visible in the foreground. (National Archives)

snatches of sleep and the efficiency of the recovery became clearly reduced.

Once tanks had been recovered to the workshop, Shields felt that "Repairs should be as far as possible limited to the exchange of complete assemblies unless damaged assemblies can be repaired simply and rapidly." In the case of damaged assemblies, the view was that "repair of assemblies should be carried out by some workshop organisation in rear of Tank Brigade Workshop and the repair assembly returned to the Tank Brigade Workshop." This anticipated the principle that would later be adopted of echeloned workshops, in which each higher echelon further behind the lines would accommodate larger and more sophisticated workshops capable of longer-term repairs. As such more extensively damaged vehicles or assemblies could be passed backwards to the level of workshop that was most appropriate to deal with them. This could have been enacted within the BEF if a suitable protocol had been in place to evacuate tanks to the Advanced Ordnance Workshop and then if necessary to the Base Ordnance Workshops, although in the event the Advanced Ordnance Workshop at Arras would also find itself in a vulnerable position due to the rapid advance of the German Heeresgruppe A. The complete assemblies that Major Shields suggested ought to be held by the brigade workshop encompassed engines, gearboxes, steering clutches, suspension units and batteries, with certain loose items such as track pins and engine heater plugs also being stored. He thought that the armoured units themselves could hold more spares, such that "The Battalions should carry more adequate supplies of tracks", especially as "In May there was a serious shortage of tracks for Mark I Infantry Tanks." He accordingly purported that "If the above policy were adopted the quantity of binned stores could be considerably reduced and the balance carried by some formation in the rear of the Tank Brigade Workshop." Shields noted that certain defects had been sufficiently common that they required investigation

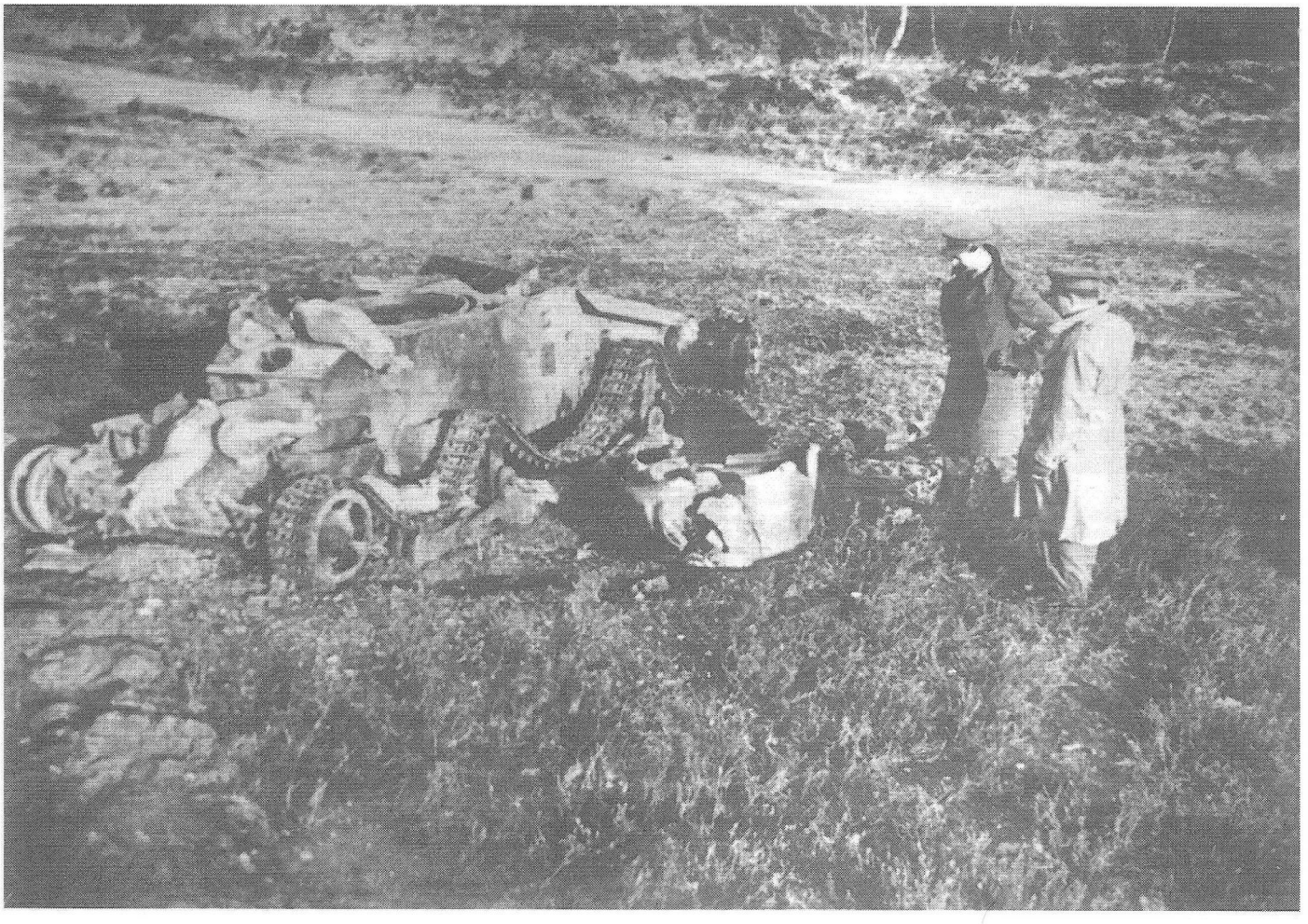
for amelioratory action by the tank manufacturers. Most of these issues pertained to the Infantry Tank Mk. II, and included gearbox and Rackham steering clutch failures, the burning out of engine heater plugs, and the breakage of track pins. For the Infantry Tank Mk. I he highlighted only the gear selector lever as needing design improvement. When it came to the location of the tank brigade workshop, the suggestion was that:

> A Tank Brigade Workshop should as far as possible be located so as to allow small fluctuations of the front without movement of the workshop so as to enable the workshop to remain in one position for a minimum of 6 days. During May 1940 the frequent movements of the workshop rendered repair work exceptionally difficult and almost impossible. It should be borne in mind that when a move is impending all tanks must, as far as possible, be brought into a condition, in which they can be towed and steered, thus limiting the degree to which a tank can be dismantled.

In France, the tendency of the workshop to straggle behind the brigade itself had been deeply injurious to its effective functioning, although the speed of the German advance had rendered events particularly fluid. Had the Dyle Plan not been effected, and the brigade remained in the frontier area, it may have been that a more stable and productive relationship between the brigade and workshop was established. Certainly the opportunity may have been available to more permanently establish the Forward Ordnance Depot stores, and thus free up the recovery trailers. In total, the workshop had made seventeen moves during its 23 days on the Continent, its longest stay being five days at Breval from the 7th to the 12th May, and its shortest being two hours each at Tressin, Vermelles and Ploegsteert, although a section of the workshop had remained for longer at the latter location. When it did come to a move, Shields' advice was that:

> A Tank Brigade Workshop should whenever possible, be given 36 hours notice of a move to enable evacuation of tanks to be commenced before the actual

The Queen is dead. The end of the Blacker Bombard trial on Matilda, the wrecked turret being visible upside down next to the hull. (National Archives)



move and to enable dismantled tanks to be brought into a towable and steerable condition. The destination should be given with the notice of the move.

Shields also observed that moves had also been hampered by the need to undertake simultaneous recoveries from the field, while the need to tow both the FOD stores and disabled tanks had led to moves having to be made in three successive stages. On occasions this had resulted in tanks having to be abandoned, as the enemy occupied the previous workshop area before the final stage could be completed. One consequence of the semi-autonomous nature of the brigade workshop, and its tendency to follow in the wake of the brigade headquarters, was that it did not have established communications with other RAOC organisations. Major Shields argued that the "Tank Brigade Workshop should be constantly informed of location of the nearest L of C Recovery Section, Ordnance Field Park, Advance Base Depot and Army Field Workshop." This was because:

> Such information is vitally important to enable the Tank Brigade Workshop to obtain spares not available within its own stores and to obtain assistance in urgent evacuation of tanks. During the month of May, five Infantry Tanks were unavoidably lost through insufficient recovery with the Tank Brigade Workshop. These could probably have been moved with the assistance of an L of C Recovery Section.

This pointed to another issue that had dogged the BEF in France, which was the poor quality of their signalling, with each formation, and sometimes each individual unit, being responsible for their own signals network, such that signals had not been integrated into a coherent whole. This problem applied to both line and wireless communications, and was the reason why so much messaging had been dependent on the hazardous and unreliable method of using dispatch riders. Indeed, the service of these latter had been rendered even more fallible by the clogged roads resulting from refugees and the haphazard movements of military traffic, as well as the constant threat of air attack. The pace of events, and the resulting movements of headquarters and units, had frequently had the ramification that when dispatch riders arrived at their destination, the recipients were no longer there. A higher level review of events was issued by the War Office's new AFV directorate (DAFV), headed by Vyvyan Pope, which had replaced SD7 as the higher administrative body for the Royal Armoured Corps. This was entitled *Report on the Alterations in Organisation, Equipment and Training Required in the Light of the Recent Experience of the B.E.F. in Flanders*, although its author(s) were anonymous, and it was undated. The paper gave a measured assessment of the performance of the German panzers, outlining that:

> The Germans seem to have employed their armoured divisions on a single plan co-ordinated by a single authority. They struck at the weakest place they could find; when they found serious resistance they manoeuvred round it, if possible, and sought to turn the flanks and rear. They did not hesitate to infiltrate in gaps between held positions provided they did not encounter serious opposition. When counter-attacked, they gave ground rapidly unless they were in very superior numbers.

This demonstrated that the major German concern was to maintain the speed of their advance rather than allow themselves to be slowed down by becoming engaged in fighting, this principle being in consonance with their strategic aim, which was to cut the Allied lines of communication to the depots further south. This ran counter to the current RAC doctrine that insisted that the purpose of armoured formations was (in the case of the armoured divisions) to write down the enemy armour or (in the case of the Army tank brigades) to overcome defensive positions. As such, the British mistook the behaviour of the German armour as being the result of excessive timidity, as:

> If the major tactical plan was bold, its execution was often cautious. Armoured vehicles, motor cyclists, anti-tank guns and artillery worked in the closest co-operation and touch, but were slow to follow up an advantage if serious fighting was likely to be involved and often contented themselves with shooting up an area without pressing on to clear it of our troops unless these were palpably outclassed or outnumbered.

In fact the German armour, in avoiding unnecessary contact with the enemy, preserved itself as a force in being to achieve the strategic aim, whereas the British conception of the use of armour would, in the desert, result in armoured formations being written down excessively quickly. However, certain aspects of German caution had proven beneficial to the Allies, as they "seldom, if ever, operated by night and the success of our long and difficult withdrawals was largely due to that fact." One area where the Germans had particularly excelled was in air-to-ground liaison, as:

> The close co-operation of the German air force with armoured divisions was very good indeed. As soon as

the dive bombers had delivered their attacks, the tanks went in to take full advantage of any confusion caused. This type of action was particularly effective when our troops had concentrated in anti-tank localities, the dive bombers driving them out into the open where the tanks engaged them.

Indeed a particularly effective example of this cooperation had been demonstrated at the expense of 6 DLI in Beaurains. Somewhat more encouraging had been the relative performance of British tanks, as:

In tank v tank battles the Germans did not show up to advantage unless they could oppose medium tanks against our light tanks. They avoided our Mk. I and Mk. II tanks at Arras, and were held all day by them in their attacks upon our right flank north of Vimy. They failed, though in greatly superior numbers, to press home their advantage against our cruiser tanks south of Calais; in fact they never at any time achieved a decisive success against any of our tanks armed with a 2-pdr. gun.

The 2 pounder was singled out for particular praise, although there were warnings against its encroaching obsolescence, while it was suggested that Infantry tanks should be capable of an average road speed of 12 mph (20 km/h), which the A12 was in fact capable of achieving, although this would be near the top of its speed range. Regarding serviceability, it was recalled that:

Maintenance was hampered by the shortness of time available, the inaccessibility of many parts and the shortness of spare parts and assemblies. Nevertheless, unit fitters, L.A.D.s and Workshops worked untiringly to keep tanks in action, and their success, though only partial, was surprising in view of the most adverse circumstances.

While these points were pertinent, the biggest issue was the absence of consideration of what an efficient repair organisation would look like, and therefore an appreciation of the sheer scale of the organisation necessary. By the middle of the war an entirely new arm of service would be instituted to deal with automotive repair, this being the Royal Electrical and Mechanical Engineers (REME), although the focus at this particular time was still rather parochial, it being reckoned that:

The chief obstacles to be overcome are rather inaccessibility and lack of standardisation. The former at present makes hours of preliminary work necessary in order to effect a minor repair, whilst the latter necessitates hand-fitting of spare parts.

The over-complexity of the Infantry Tank Mk. II rendered it particularly laborious to maintain and service, which would lead to it being eventually superseded by the Infantry Tank Mk. III, despite the latter tank's slightly inferior fighting qualities. The paper additionally asserted that:

It would be a grave mistake to assume that because it was not found possible to repair many vehicles suffering from comparatively minor technical defects, any decrease can be made in the scale of spare parts laid down. On the contrary, that scale should be increased in the maximum consistent with the flow of new vehicles. There are very few armoured vehicles which cannot be salved and reconditioned or repaired provided time and opportunity is given.

In the event, the immediate emphasis on producing new vehicles and tanks to equip the rapidly expanding Army would have an adverse effect on the production of spare parts, although this mainly affected units training at home rather than those in operational theatres. On the topic of signals, the recollection was that:

In some units the wireless did not function altogether satisfactorily, but its supreme importance to armoured troops was established beyond doubt. There was a shortage of spares, of charging sets and of R.C. [Royal Corps] Signal personnel in general, and the pace of the operation was such that time for maintenance and the charging of batteries was inadequate.

The limitations of the one-man turret of the Infantry Tank Mk. I, were particularly pertinent when it came to maintaining effective communications, as:

In action it became apparent that a wireless operator who has no other duties to perform is essential if communication is to be ensured at all times. This requirement involves the production of a turret holding at least three men, and it is considered that at least the tanks of all commanders down to troop commanders must have a three-man turret.

On the more mundane matter of managing the reduced stock of Infantry Tank Mk. I's that were still being operated in the United Kingdom, a meeting was held at the Ministry of Supply on 13th June, this ostensibly being to consider the accelerated production

programme for the Infantry Tank Mk. III. It was nonetheless reported at the event that "It was decided to stop production of spare tracks for the Infantry Tank Mark I", and that "As this will free capacity for manganese tracks, Vickers-Armstrongs will consider a design of manganese track for the Infantry Tank Mark III." Limited development of the A11 was still continuing, and on 9th June MEE Report A249 was published on tests on cast steel sprocket rings that had been produced by the Ford Motor Company in their own No. 7 steel, these having unhardened teeth. Three sprocket rings were tested, with one on tank T3433 and a pair on T5563, all of these being run for just under 1200 miles (1900 km) with no defects being encountered. The verdict was therefore that "The cast steel sprockets appear to be of wear resisting material and are suitable for fitting to this type of vehicle." MEE Report A241 was issued on 1st August on trials of a set of detachable mud spuds that could be fitted in the field to improve soft ground performance. Four of these were fitted to a single track of an unidentified Infantry Tank Mk. I, and after some strengthening gave satisfactory performance for 100 miles (160 km) across country, while remaining undamaged after two miles (3 km) running on the road. They were then approved for production, with twenty spuds being stipulated for each track should they be used in the field by units. The brief MEE Report A289 detailed tests on a clutch plate manufactured by Newton & Bennett Ltd. of Acton, London. This was a single plate with fabric rings riveted to each side, the plate itself being comprised of a pair of steel discs separated by laminated springs. This had been run for 213 miles (343 km) on T3433, the conclusion being that the Newton disc was "Superior to the standard clutch disc and comparable with the 'Don' disc", the latter having been assessed in MEE Report A178 of November the previous year. The 6th Report of the Mechanization Board, issued on 31st July, related that the development of the coulter mine plough had been discontinued, as:

> knowledge of the detailed design of German mines showed that the Coulter device was very liable to be destroyed by mines actuated by a percussion fuse. Tests on rough and frozen ground also showed that this device had, in reality, a very limited application. It was, therefore, decided that no further experimental work on ploughs and coulters should be carried out.

The Infantry Tank Mk. I had been involved in the testing of a couple of unsuccessful alternative anti-mine devices at the MEE, these being a front mounted skid that was raised and lowered by the same winch as used for the Fowler device, and a cylindrical roller assembly that was towed behind the tank. The Director-General of Production at the Ministry of Supply, Walter Layton, issued his Weekly Report No. 30 on 25th January 1941, this showing that at the beginning of that month no less than 755 spare tracks were in store at Chilwell for the Infantry Tank Mk. I, with the War Office still being in possession of all 42 remaining vehicles. The DAFV's monthly progress report for March 1941 would reveal that 27 of these were still with the 1st Army Tank Brigade, who had 162 tanks in total. By this time the 4th and 7th battalions had departed for the Middle East, their places in the brigade being taken by the Territorial 44th and 49th battalions RTR. The progress report for June stated that issues of Infantry Tank Mk. I's were being made to the Polish forces, who were preparing to form their own armoured division in Scotland. In September 1941 the Infantry Tank Mk. II would be officially renamed the Matilda, following the policy to give names to all non-obsolescent service tanks, the original name of the A11 prototype gaining a new and more illustrious lease of life. The last test report on the Infantry Tank Mk. I would be issued as late as 23rd December 1941, with Field Trial Report FT 222 outlining the substitution of the standard bogie bearings with smaller lipped bearings supplied by the Hoffman Bearing Co. Ltd. These had the advantage of eliminating the thrust race required by the standard bearings, although one set of bearings had collapsed and another had seized after a thousand miles (1600 km) due to the inadequate sealing of the Git seals that had been provided for them. Nonetheless the verdict of the report was that "The tests confirm that this type of bearing arrangement would be a suitable alternative to the standard scheme." Unsurprisingly, no further action was taken due to the obsolete status of the Infantry Tank Mk. I.

6. CONCLUSION

The A11 occupies a unique position within British tank development, being a tentative first step in the concept of the assault tank that was intended to be superseded almost from the start. It confirmed first the viability, and then the necessity, for armour protection well beyond that which had generally been thought adequate at the time of its conception. Its presence in France was only due to the retarded development of the A12 Infantry Tank Mk. II, and the foolish decision of the General Staff not to immediately press ahead with the Valentine tank. Although only intended to be used as a training (or "drill") tank within the British Expeditionary Force, it acquitted itself well during the Battle of Arras and subsequent actions. This was mainly due to the choice to adopt a 60 mm basis which was not only immune against the existing 3.7 cm German anti-tank guns, but would also be highly resilient to the next generation of 5 cm weapons. Although the attack at Arras was effectively bungled due to hurried preparation, quite by chance it struck the Germans at the most acute psychological moment, and encouraged the enactment of the Halt Order that assisted the evacuation of the BEF to the Channel coast. Mechanically the Infantry Tank Mk. I was reasonably reliable, but as with almost all early war British tanks it lacked durability, due to the opportunistic adoption of the Ford engine and gearbox. This did however also reflect the pre-war tendency of the Royal Tank Corps to view tanks as strictly tactical, rather than strategic, weapons; a propensity which also explains the general lack of support facilities provided for the 1st Army Tank Brigade, who had an under-equipped workshop, minimal recovery facilities, and a distinct lack of reserve tanks. There were also no tank transporter units available to cover long road journeys, the efficacy of moving tanks by rail quickly being found to be marginal. It would take a long time for the many lessons of the Flanders campaign to filter into the British Army's organisation, and it was not until the later stages of the desert campaign that British armoured units started to be adequately equipped and supported.

Although the Infantry Tank Mk. I would be declared obsolete on the return from France, this decision was somewhat precipitous as the concept of the small, heavily armoured two-man tank had not in fact been disproved. One theatre where the A11 may still have proved useful was Singapore, as the tank would have been easily supportable within requisitioned commercial garages, would have been proof against almost all Japanese anti-tank weapons, and, when armed with 0.5-in. (12.7 mm) Vickers machine gun, would have been more than a match for the opposing Japanese light tanks. Indeed the concept of the one-man and two-man tank continued to be explored into 1941 and championed by the Assistant Chief of the General Staff, Gordon Macready, as a weapon to be crewed and operated exclusively by the infantry. However, as an infantry weapon, such a tank was excluded from consideration by the Tank Board, and the ACIG's advocacy could therefore advance it no further. It should be recognised that one of the most pressing problems for British infantry throughout the war was holding gained ground against tenacious German counter-attacks. A small tank moved forwards and placed in a hull down position, or even dug in if time permitted, would have provided an eminently suitable mortar-proof pillbox to resist such counter-attacks. Its small turret would have been difficult to hit with close range handheld anti-tank weapons, or with long distance armour piercing rounds. One of the biggest problems in holding gained ground was in moving sufficient ammunition forward in the limited time available to reinforce a recently seized position, and so a small tank could also have been used as a mule for facilitating just that. Ultimately the efficacy of such a weapon would have depended on it being sufficiently easy to disguise, such that the enemy would not realise that they were dealing with a tank at all.

Ultimately the A11 gave surprisingly good value, having been the mainstay of the only telling counter-attack mounted by the Allies during the Blitzkrieg period while (in contrast to the A12 and Valentine) not being a weapon that the Germans would be tempted to reuse.

7. TECHNICAL DATA

General

Weight *(laden with crew and armament)*	11 tons	11 tonnes
Length	16 ft. 3 in.	4 953 mm
Width	7 ft. 8 in.	2 337 mm
Height	6 ft. 6½ in.	1 994 mm
Track Centres	6 ft. 4 in.	1 930 mm
Track Width	11½ in.	292 mm
Ground Clearance	15 in.	380 mm
Fuel Capacity	42 gals.	190 l
Oil Capacity	1 gal. 3 pints.	6.25 l
Coolant Capacity	5 gals.	23 l
Range *(50% road, 50% cross-country)*	60 miles	100 km
Armament	0.303-in. Vickers machine gun with 3 000 rounds	
Elevation	25°	
Depression	15°	

Engine

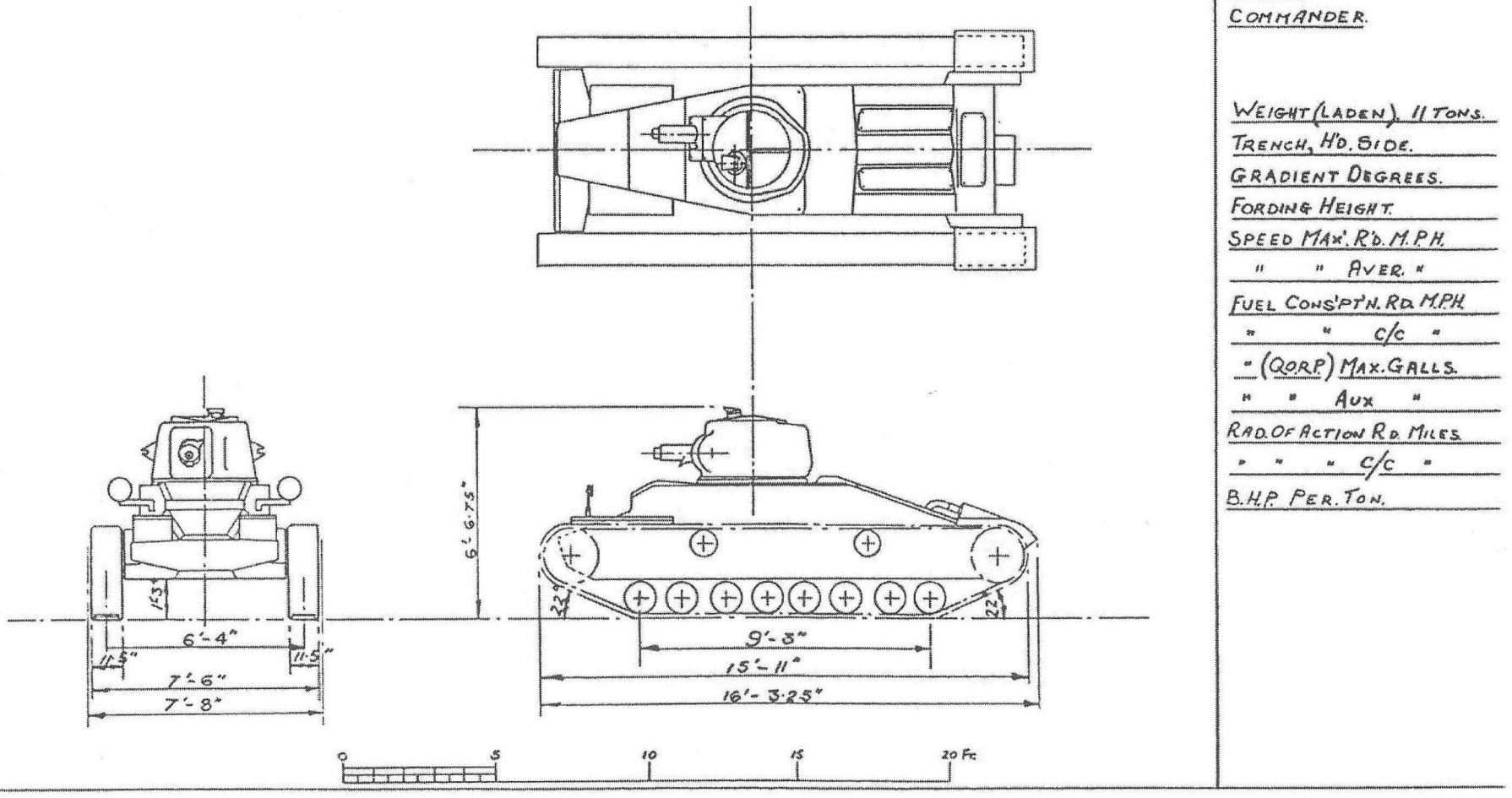
Type	Ford Model 79F-6000Bs	
Cylinders	V8	
Bore	3 1/16 in.	78 mm
Stroke	3¾ in.	95 mm
Cubic Capacity	220 in^3	3.6 l
Compression Ratio	6.12 to 1	
Maximum Power *(at 2820 rpm)*	70 bhp	52 kW
Governed Speed	2 820 rpm (8 mph)	(13 km/h)

Gearbox

Model	Ford Model 68-7204
4th Gear Ratio	Direct (1 to 1)
3rd Gear Ratio	1.69 to 1
2nd Gear Ratio	3.09 to 1
1st Gear Ratio	6.4 to 1
Reverse Gear Ratio	7.82 to 1

Production

Contract	Number	War Department Serial Numbers	Vehicle Registration Marks
T4319	60	T3433 to T3492	HMH 788 to HMH 847
T5429	60	T5551 to T5610	RMY 905 to RMY 964
	19	T8101 to T8119	PMX 458 to PMX 476



CREW.
DRIVER.
COMMANDER.

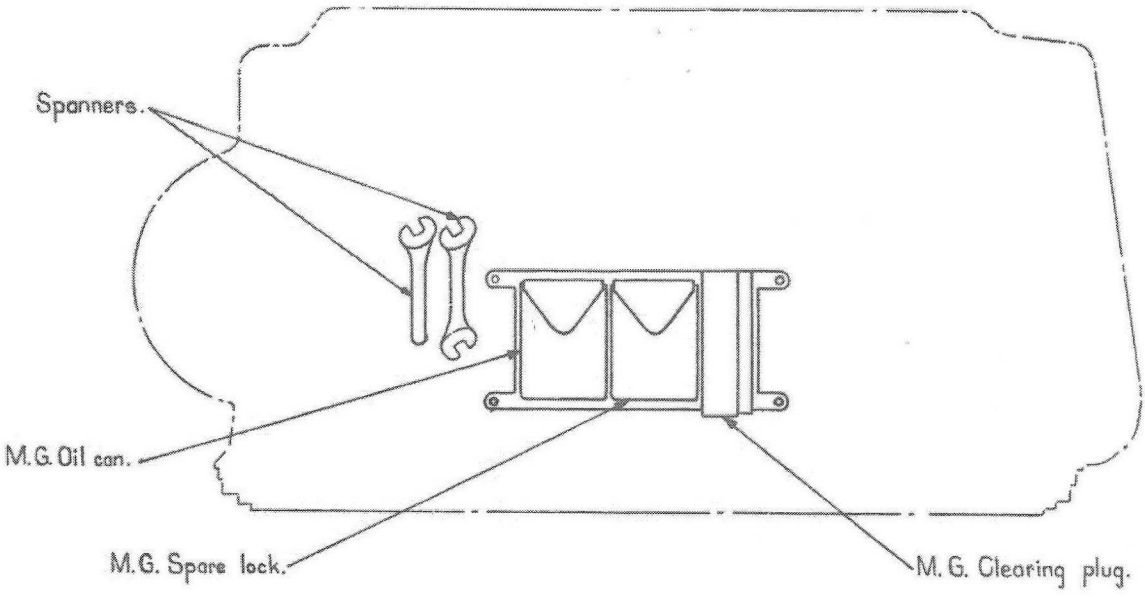
WEIGHT (LADEN). 11 TONS.
TRENCH, H'D. SIDE.
GRADIENT DEGREES.
FORDING HEIGHT.
SPEED MAX'. R'D. M.P.H.
" " AVER. "
FUEL CONS'PT'N. RD. M.P.H.
" " C/C "
" (Q.O.R.P.) MAX. GALLS.
" " AUX "
RAD. OF ACTION RD. MILES.
" " " C/C "
B.H.P. PER. TON.

A11 INFANTRY TANK MK.I.
OUTLINE.

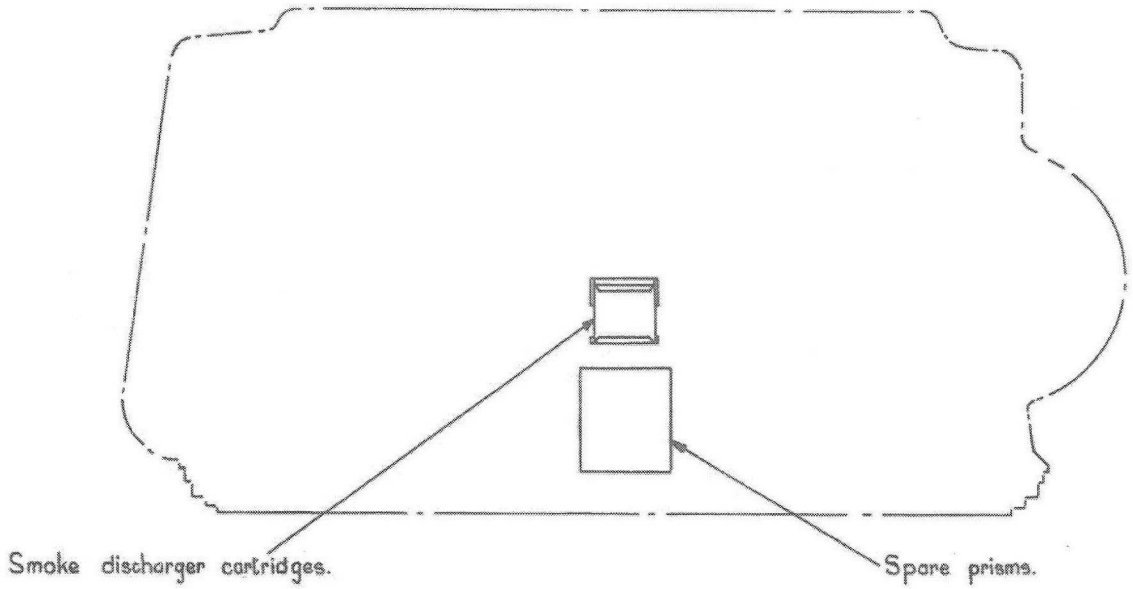
Plate I.

TANK, INFANTRY, MARK I.

VIEW SHOWING LOCATION OF STORES IN TURRET.



R. H. WALL.



L.H. WALL.

R.1809.

TANK, INFANTRY, MARK I.

VIEW SHOWING LOCATION OF STORES IN HULL (LEFT SIDE PLATE).

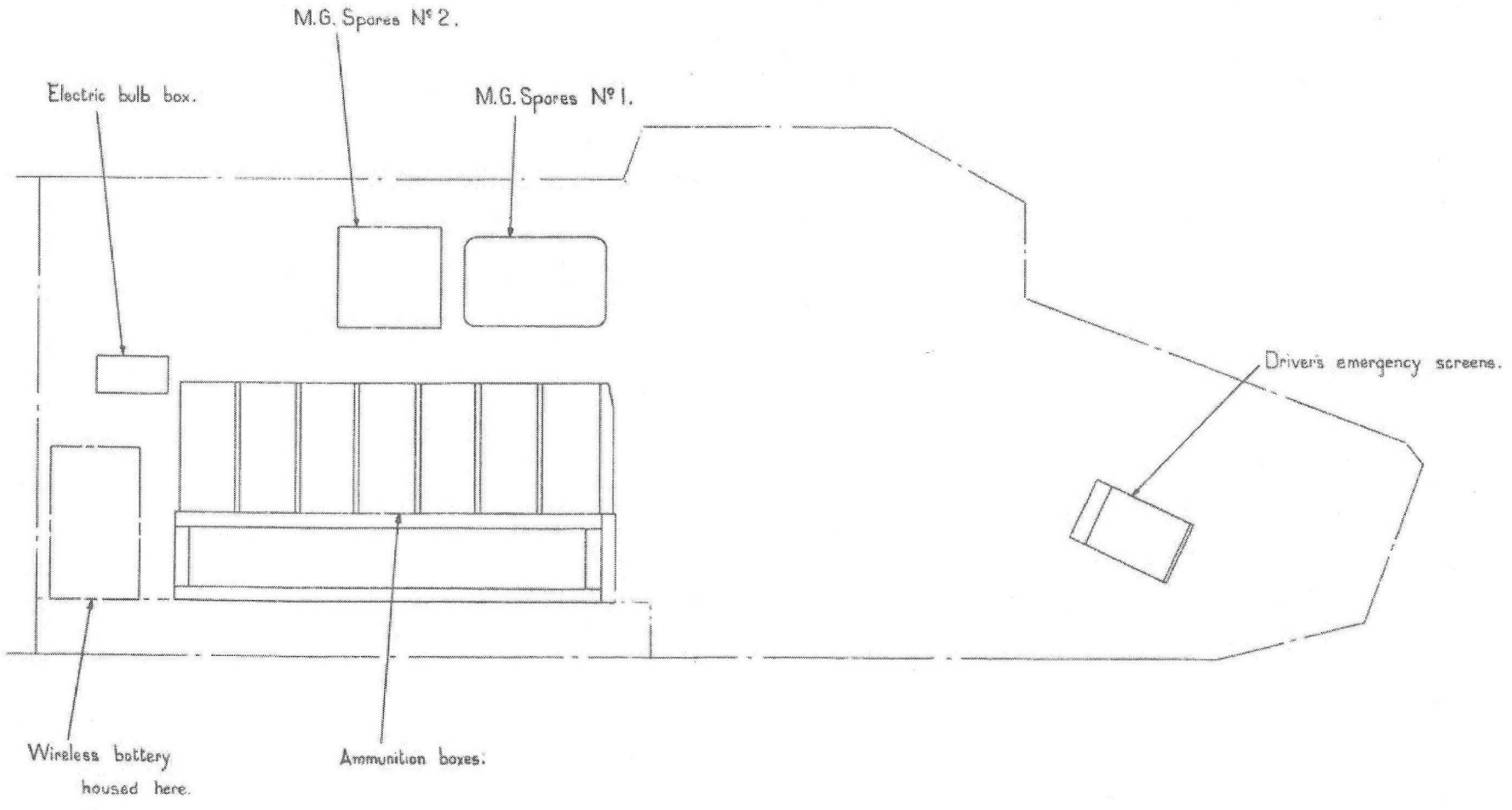
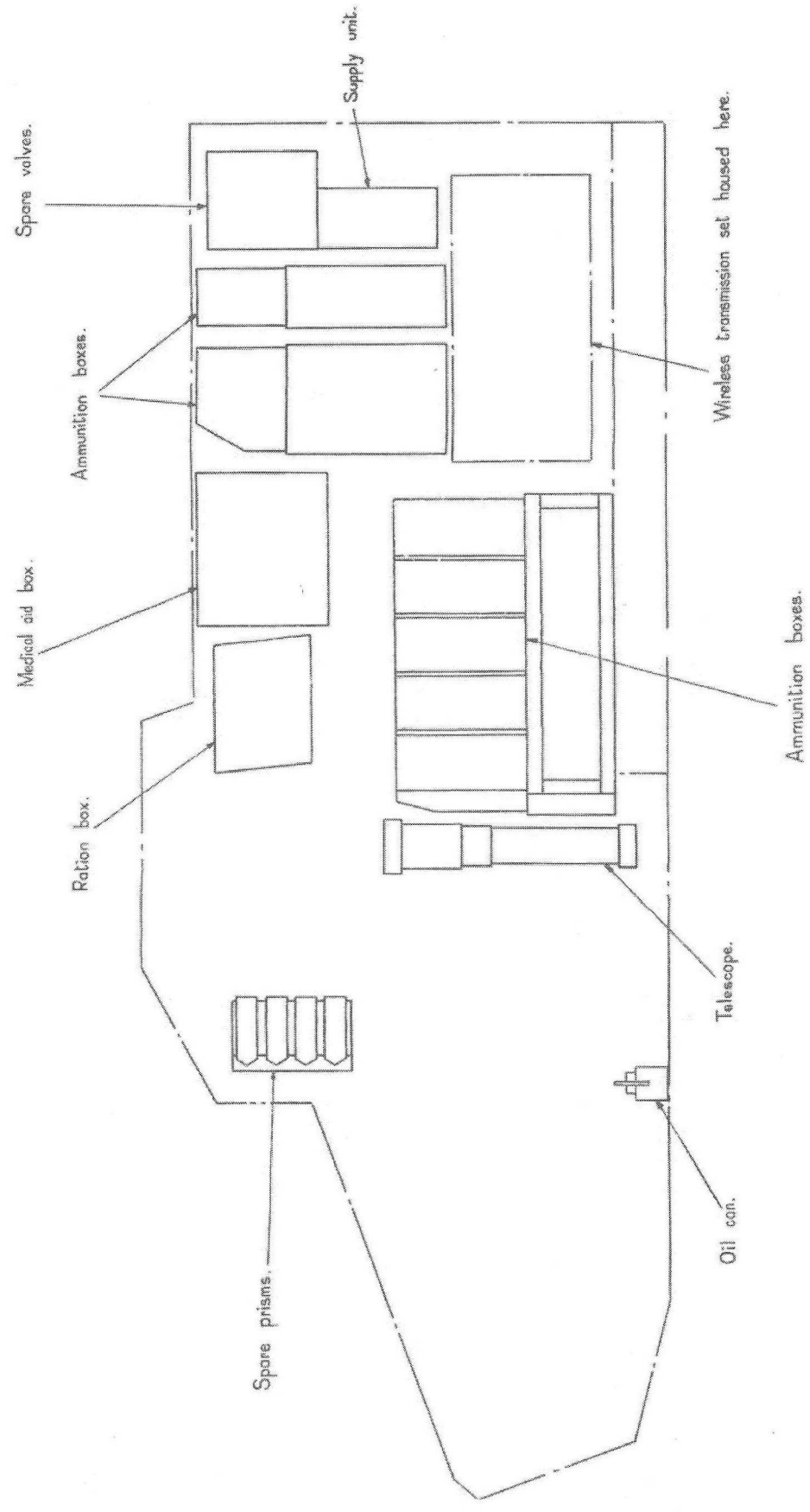


Plate 3.

TANK, INFANTRY, MARK I.

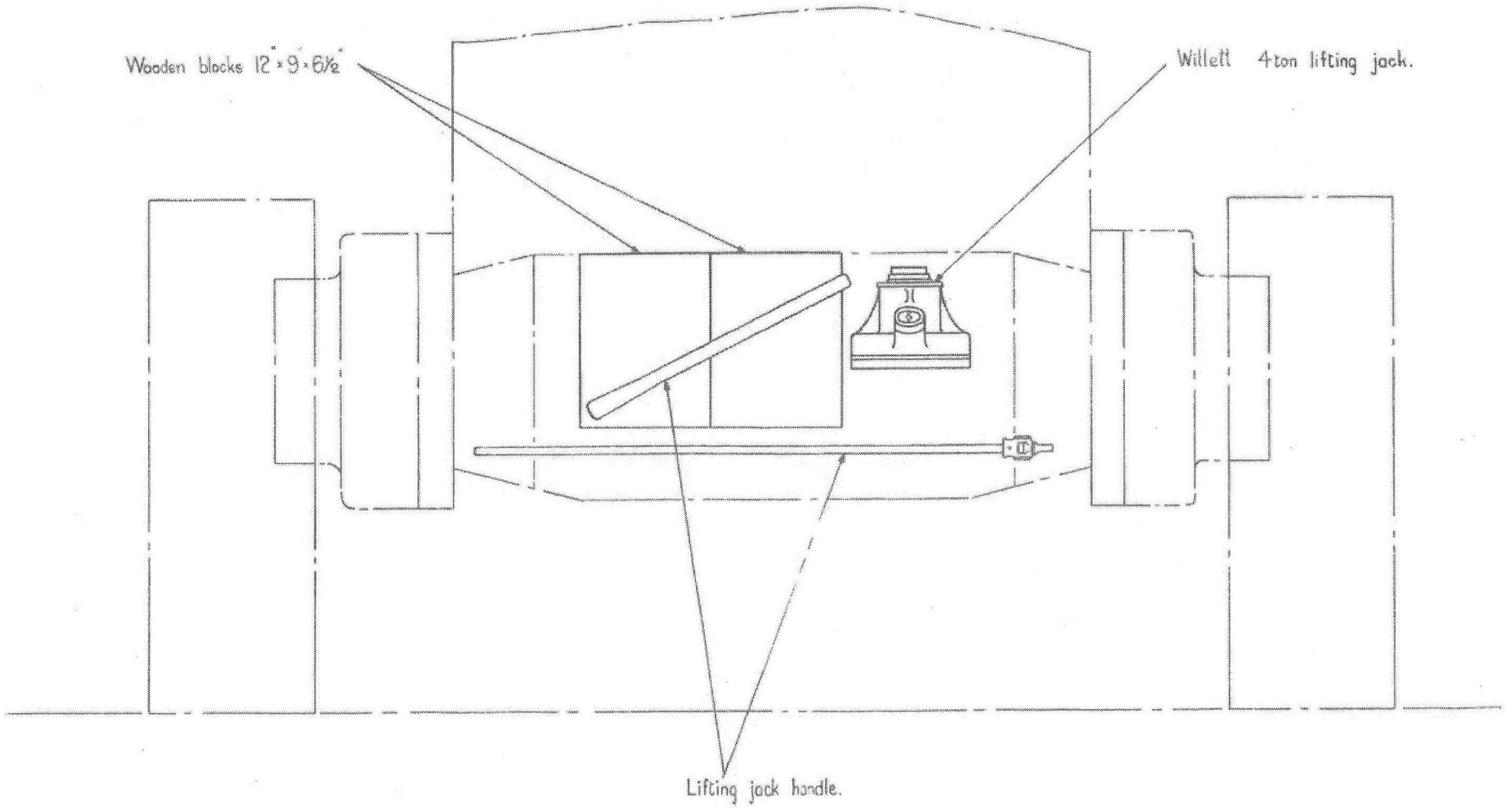
VIEW SHOWING LOCATION OF STORES IN HULL (RIGHT SIDE PLATE).

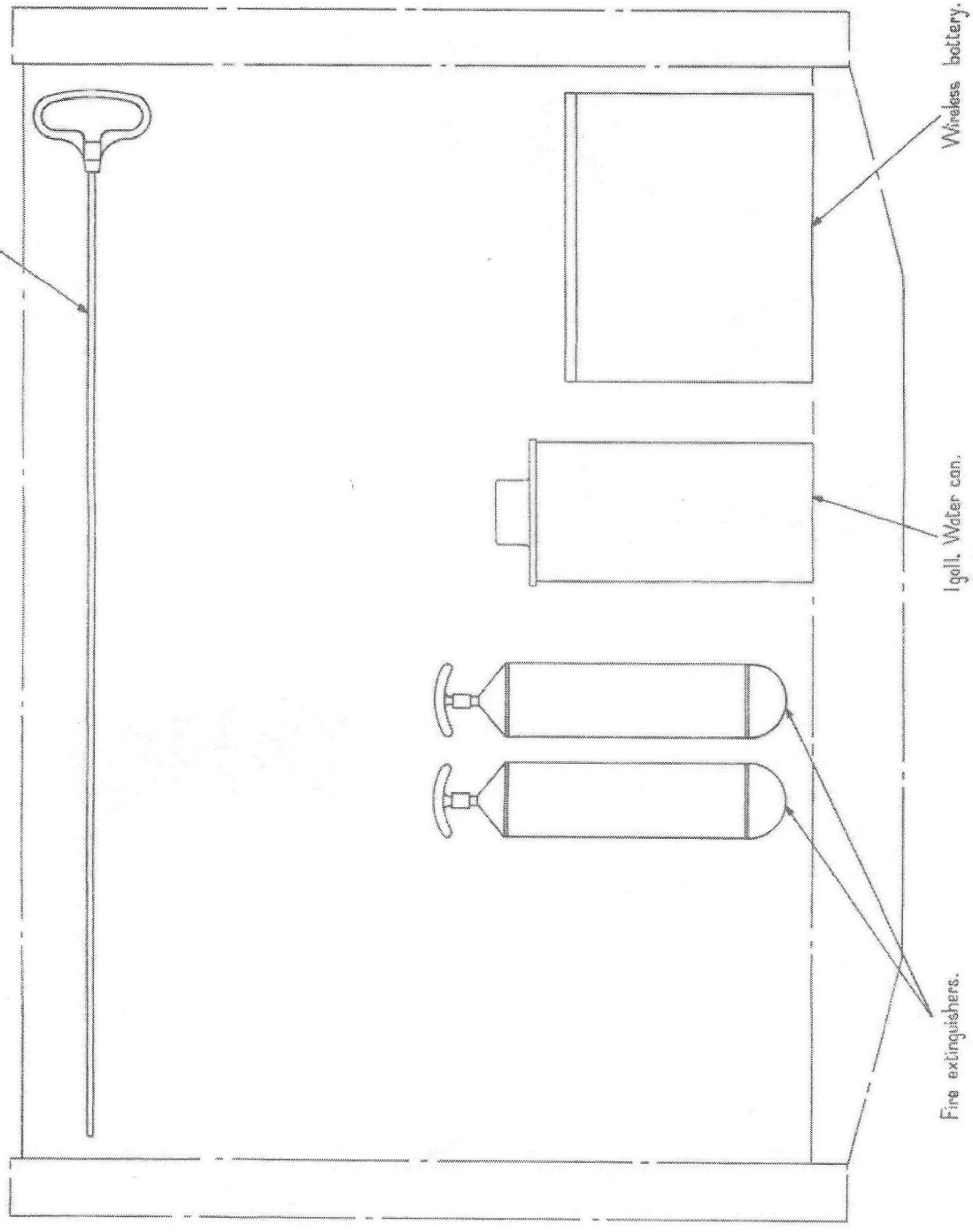


R.1809.

TANK, INFANTRY, MARK I.

VIEW SHOWING LOCATION OF STORES ON REAR PLATE.





TANK, INFANTRY, MARK I.

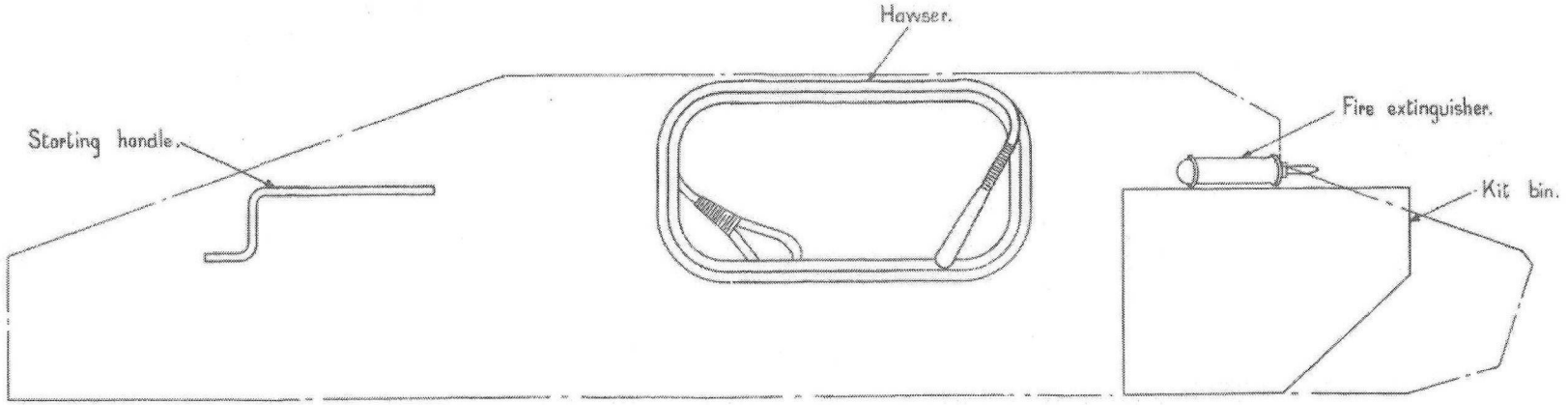
VIEW SHOWING LOCATION OF STORES ON BULKHEAD.

Plate 5.

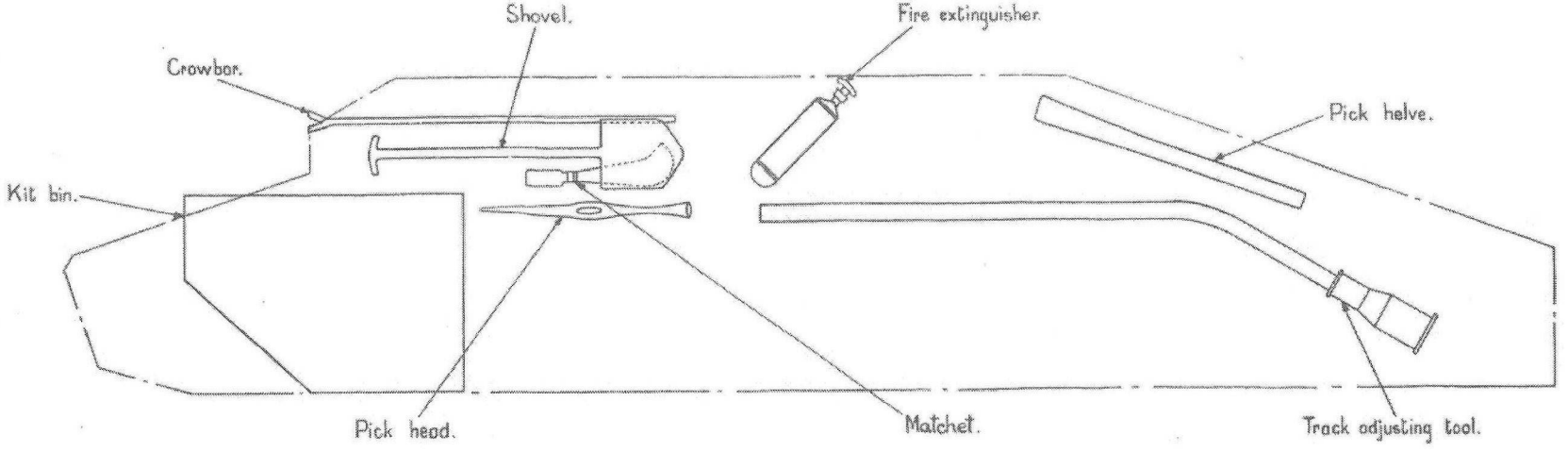
R.1809.

TANK, INFANTRY, MARK I.

VIEW SHOWING LOCATION OF STORES ON HULL (EXTERNAL).



OFF SIDE.



NEAR SIDE.

R.1809.

Plate 7.

TANK, INFANTRY, MARK I.

(Fitted with the Mark I, N°1 Coulter Attachment.)

VIEW SHOWING LOCATION OF STORES IN HULL. (LEFT SIDE PLATE.)

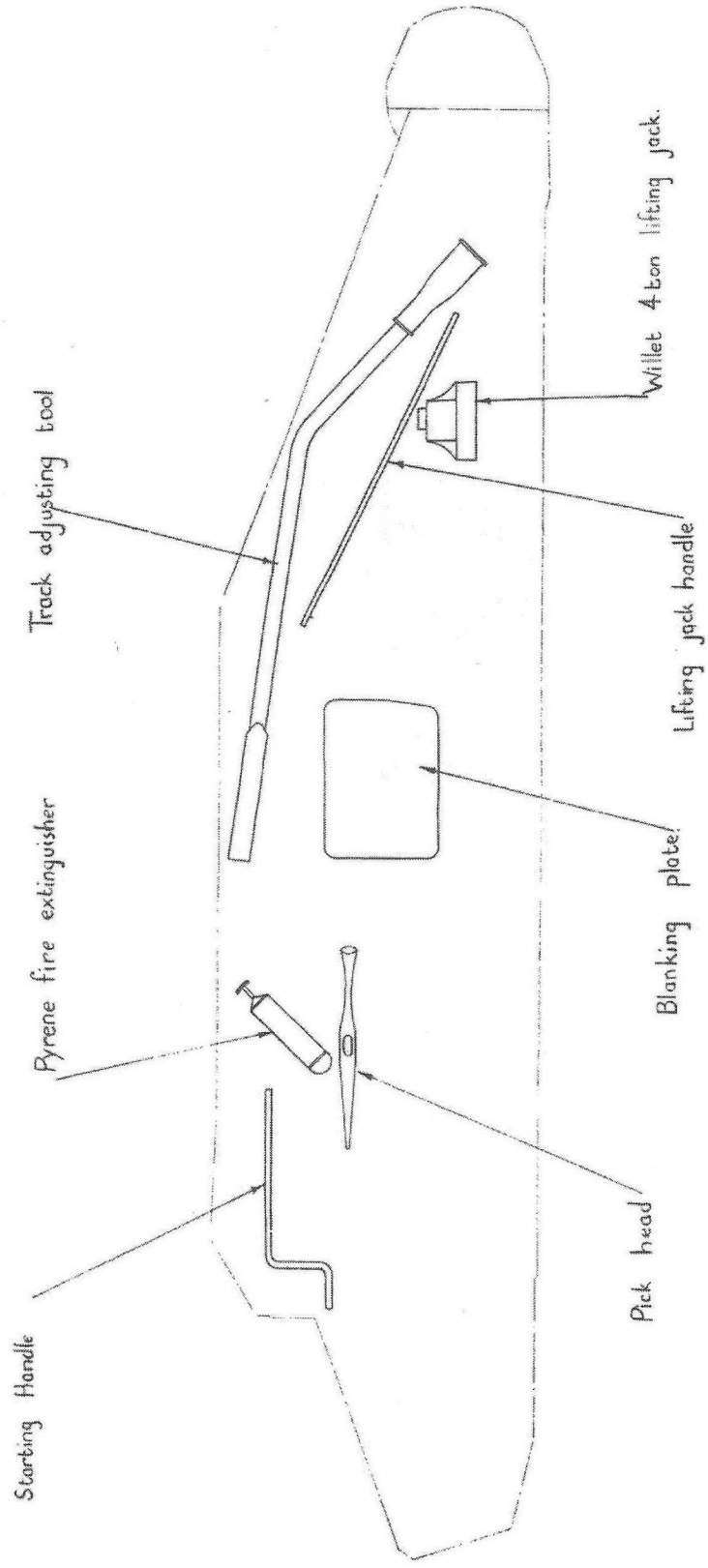


Plate. 8.

TANK, INFANTRY, MARK I.

(Fitted with the Mark I, N°. I. Coulter Attachment.)

VIEW SHOWING LOCATION OF STORES IN HULL. (RIGHT SIDE PLATE.)

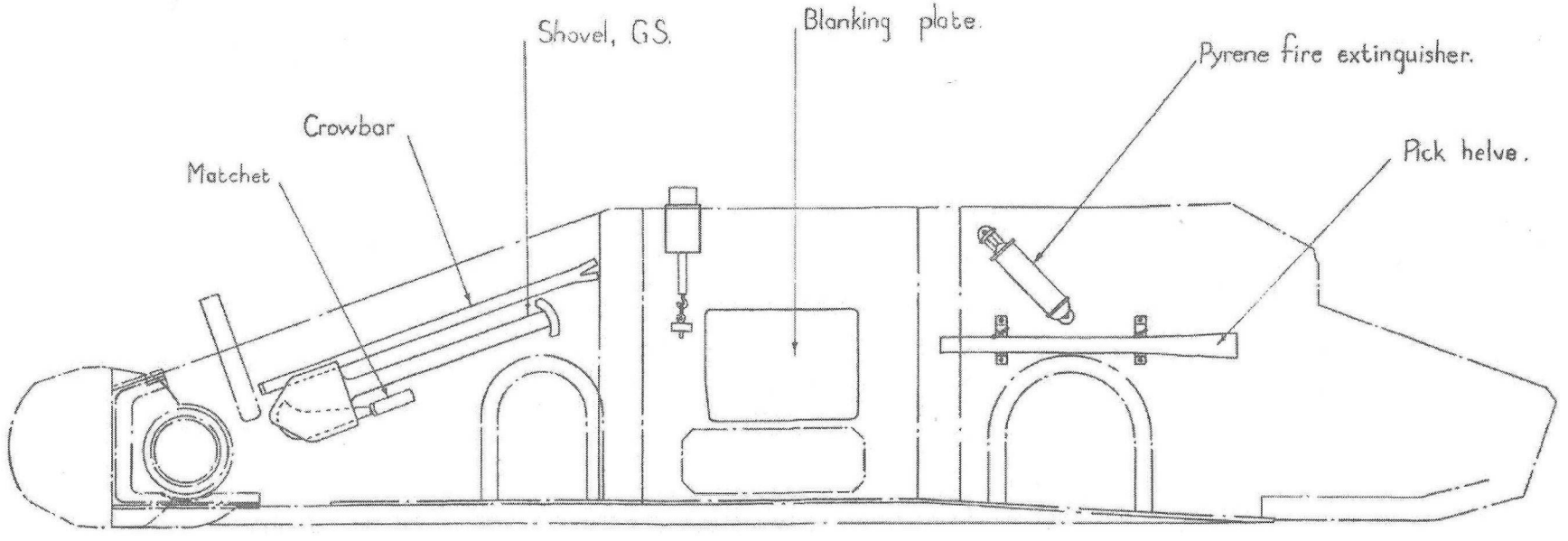
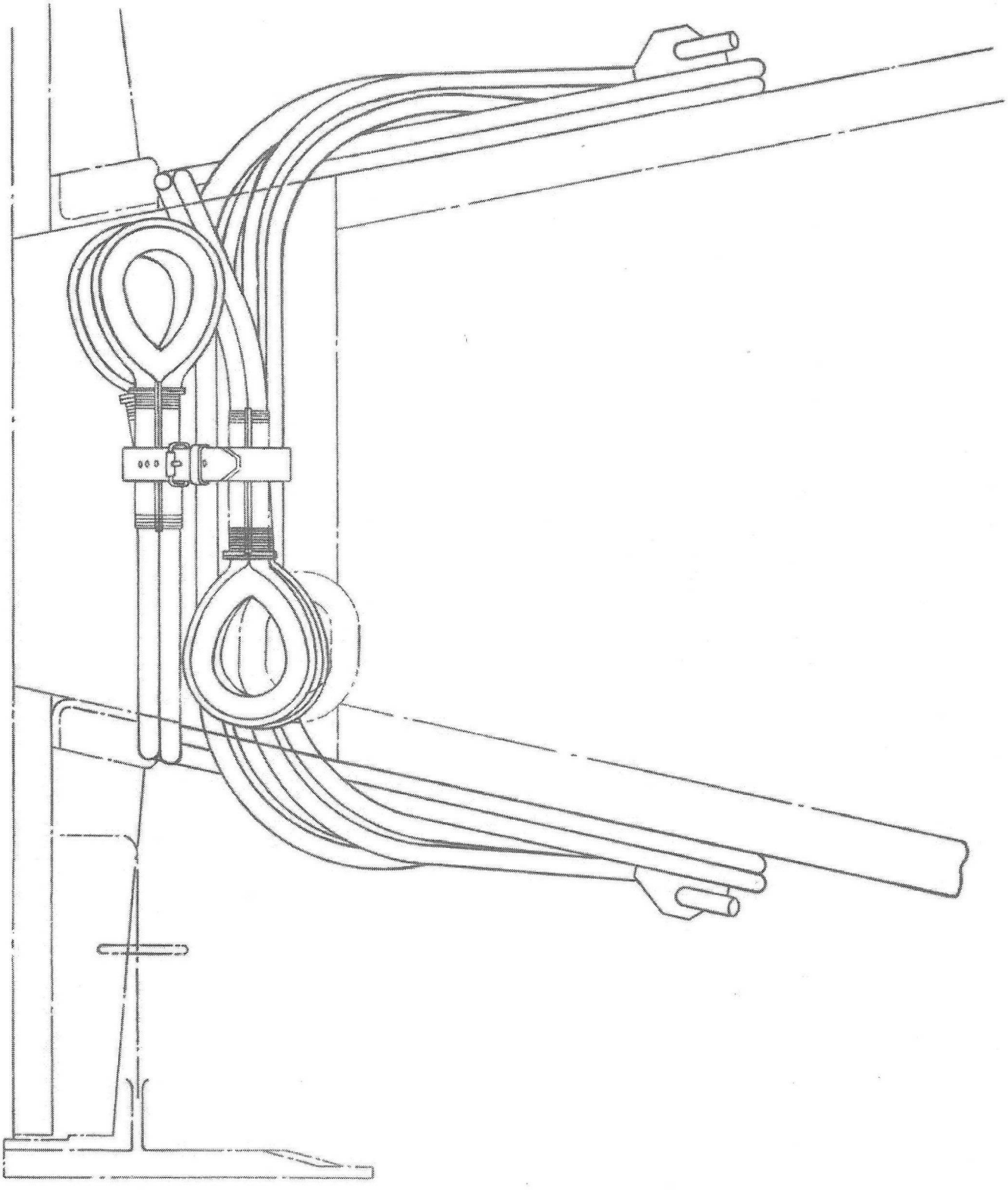


Plate 9.

TANK, INFANTRY, MARK I.

(Fitted with the Mark I, N°. I. Coulter Attachment.)

VIEW SHOWING LOCATION OF HAWSER.



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* After retiring from the Army and receiving his knighthood, E.M.C. Clarke would be known as Sir Campbell Clarke.

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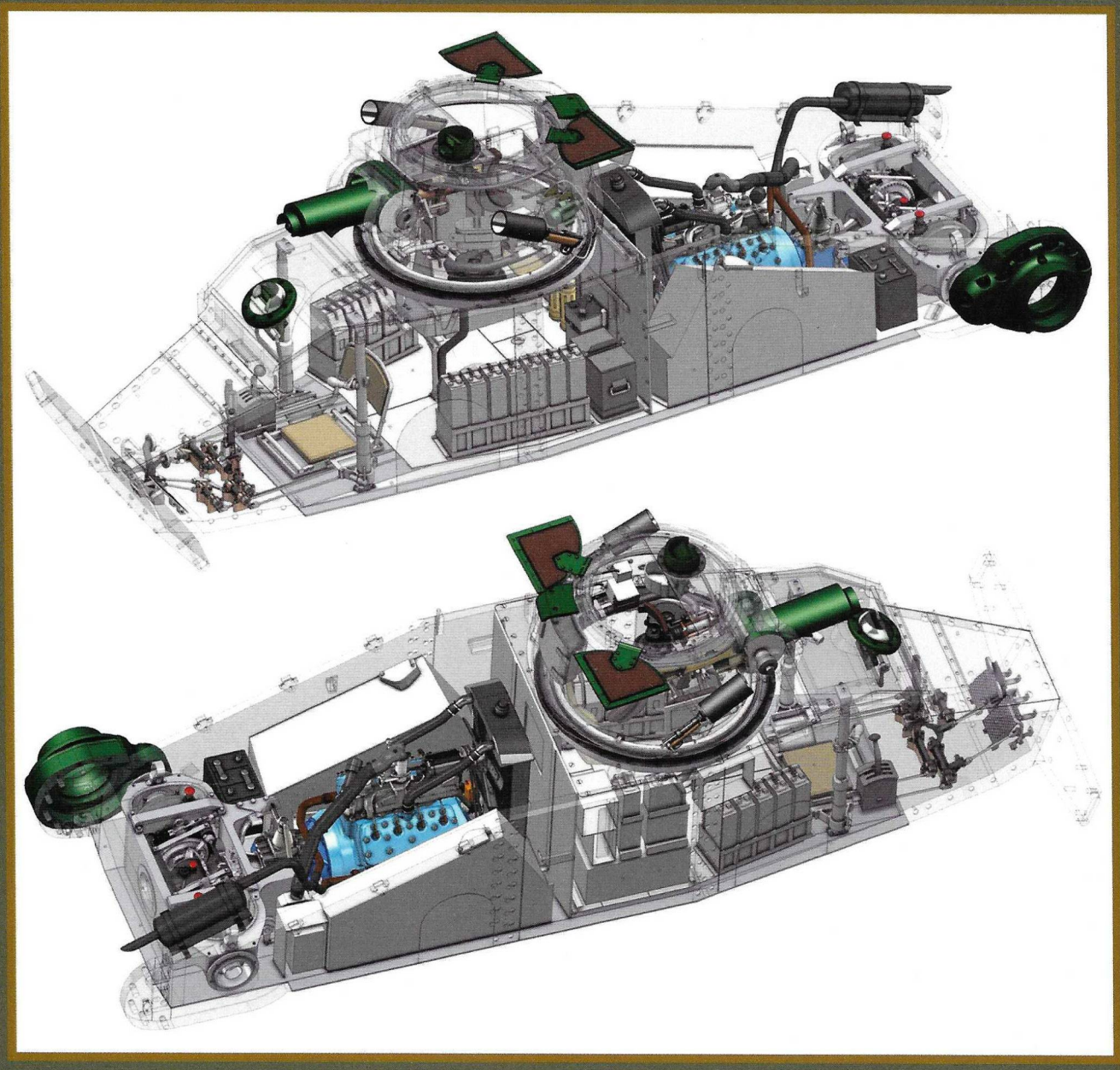

The In-depth History Of The Infantry Tank Mk.I

The Infantry Tank Mk.I was birthed nefariously under the pseudonym of Matilda due to the various intrigues that afflicted the War Office's tank development organisation in the pre-war era. These in turn were caused by pecunious circumstances and the strong differences in the ideas favoured by the major proponents of armour policy. Designed as a small two-man tank to accompany the infantry during assaults on prepared positions, it was soon rendered obsolete by its successor, which would more famously adopt the Matilda name. However, delays in producing the Infantry Tank Mk. II would see the Mk.I be shipped to France in volume, where it would fight a significant action in delaying the German advance, this being both the height of its achievements and its swansong.

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